MACKENZIE VALLEY PIPELINE INQUIRY

IN THE MATTER OF APPLICATIONS BY EACH OF
(a) CANADIAN ARCTIC GAS PIPELINE LIMITED FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE YUKON TERRITORY AND THE NORTHWEST TERRITORIES, and
(b) FOOTHILLS PIPE LINES LTD. FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE NORTHWEST TERRITORIES
FOR THE PURPOSE OF A PROPOSED MACKENZIE VALLEY PIPELINE

and

IN THE MATTER OF THE SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACT REGIONALLY OF THE CONSTRUCTION, OPERATION AND SUBSEQUENT ABANDONMENT OF THE ABOVE PROPOSED PIPELINE

(Before the Honourable Mr. Justice Berger, Commissioner)

Inuvik, N.W.T.

January 29, 1976

PROCEEDINGS AT INQUIRY

Volume 120

ALLWEST REPORTING LTD.,
4299 CANADA WAY,
BURNABY 2, B.C.

APPEARANCES:

Mr. Ian G. Scott, Q.C.,
Mr. Stephen T. Goudge,
Mr. Alick Ryder and
Mr. Ian Roland — for Mackenzie Valley Pipeline Inquiry;

Mr. Pierre Genest, Q.C.,
Mr. Jack Marshall, and
Mr. Darryl Carter — for Canadian Arctic Gas Pipeline Limited;

Mr. Reginald Gibbs, Q.C.,
Mr. Alan Hollingworth &
Mr. John W. Lutes, — for Foothills Pipe Lines Ltd.;

Mr. Russell Anthony &
Pro. Alastair Lucas
Mr. Garth Evans — for Canadian Arctic Resources Committee;

Mr. Glen W. Bell and
Mr. Gerry Sutton, — for Northwest Territories Indian Brotherhood, and Metis Association of the Northwest Territories;

Mr. John Bayly
or
Miss Leslie Lane — for Inuit Tapirisat of Canada, and The Committee for Original Peoples Entitlement;

Mr. Ron Veale and
Mr. Allen Lueck — for The Council for the Yukon Indians;

Mr. Carson H. Templeton, for Environment Protection Board;

Mr. David Reesor — for Northwest Territories Association of Municipalities;

Mr. Murray Sigler — for Northwest Territories Chamber of Commerce.

Mr. John Ballem, Q.C., — for Producer Companys;

I N D E X

Inuvik, N.W.T.

January 29, 1976.

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. BAYLY: Before we begin the cross-examination of Dr. Pimlott, I'd like to express a concern that the Committee for the Original Peoples Entitlement has with regard to the scheduling of hearings of the Arctic Waters Oil & Gas Advisory Committee, and I don't want to go into the things that this Committee is to consider because I understand the problems of their terms of reference being different from your own, sir. I'm only interested for the purpose of this expression of concern to inform you that, for various reasons, we feel that the scheduling may affect the participation in your Inquiry, and in particular at the community hearings which have been scheduled for February and March.

Now, we first heard of the schedule of these hearings in detail in the middle of January and when we had heard this, a telex was sent to the Minister on January 14, 1975 and going to the particular area of concern to this Inquiry, we said in this telex:

"We wonder why your Department at this time is sending groups such as the Regional Planning Committee and the Arctic Waters Oil & Gas Advisory Committee into communities to discuss issues Berger will be pursuing in another few weeks. We trust it is not an attempt to confuse people and usurp the authority, or jeopardize

"the success of the Berger Inquiry."

And later in the telex,

"Any attempt to subvert the process of the Berger Inquiry must be protested in the strongest terms."

Now, we failed to receive a reply to that by the 20th of January, and sent a telegram to the Minister, asking for a reply, and a reply was sent signed by the Minister dated January 23, 1976, in which there was no reference to the conflict between the scheduling of the hearings and the scheduling of the Berger Inquiry with the exception of the last paragraph, in which it says:

"It is perhaps regretable that all these matters have come before us at the same time, but there would be no advantage to delaying the community meetings which I regard as an important component of the decision-making process."

In reply to that, Sam Raddi sent a telex to the Minister again in which the following statements were made:

"We are asking that the community consultations by the Arctic Waters Oil & Gas Advisory Committee be meaningful, not token; to help make it meaningful we are asking that you postpone the tour until after the delta phase of the Berger Inquiry, which will be about three weeks. We are not asking that the Arctic Waters Oil & Gas Advisory Committee not hear the communities

as part of their decision-making process."

And later in the telex on the same subject,

"I am concerned that the great rush to have meetings by the regional plan, Palliser information tour, the Arctic Waters Oil & Gas Advisory Committee and the Berger hearings will render community meetings useless. People are prepared for Berger."

And later in the telex,

"There was never any consultation with the communities or us as to when would be the best time to have the hearings."

Now, in reply to that we received, signed by the Secretary of the Arctic Waters Oil & Gas Advisory Committee in Yellowknife an itinerary with the hearings set out as follows:

On the 3rd of February, Holman Island and Sachs Harbour.

On the 4th of February, Paulatuk and Tuktoyaktuk.

On the 5th of February, Aklavik.

On the 6th of February, Inuvik.

No mention again of the concern that was expressed.

A telex was also received dated January 28, 1976 from the Deputy Minister in which no mention was made of this concern, and sir, we raise this with you because we feel that it maybe

a matter that you wish to consider in the light that it may affect the success of the community hearings which you have scheduled in the delta communities. We wish to state that we view with grave concern any action, whether accidental or conscious, to jeopardize the success of your Inquiry.

We did learn by way of parallel example that when the Science Council last spring informed the Department of Indian Affairs of its intention to hold hearings in Inuvik, at that time the hearings were re-scheduled because of the concern that the Department felt that it might jeopardize your Inquiry. We have brought these concerns up with regard to their own hearings, and we have not even had an acknowledgment. I realize your position in this, sir, and that you're not in charge of what the Arctic Waters Oil & Gas Advisory Committee does, but there may be a point that goes to the success of your own Inquiry, which is a concern to you.

THE COMMISSIONER: Well, thank you, Mr. Bayly. Any questions of Dr. Pimlott?

MR. LUTES: I have no questions.

MR. CARTER: No, I have no questions.

DOUGLAS PIMLOTT, resumed

CROSS-EXAMINATION BY MR. GOUDGE:

Q Let me begin with you by seeing if I understand your evidence as it relates to the environmental programs you say ought, in an

optimum sense, to go on before any offshore drilling is undertaken in substantial quantity.

To take you back to the beginning, I understood you to say that you would have preferred the Beaufort Sea program to have been a 3-year program rather than a one year or two year program, that you thought three years were required for the assessment that that program was intended to carry out. Is that correct?

A Yes. I use three years, I stated that three years was the minumum that I considered was required. In the time that I worked with the science council I was forced to think a great deal about times for ecological studies, because there's a great inclination for natural scientists, I guess particularly on the ecological side, to talk about, oh we need ten or fifteen years, and quite frequently I guess other processes and other options in society are, in the offing must be considered at the same time.

And so when I talk about this personally, I tend to be, to go down to what I think are minimums, and in talking about a minimum three year period, I was just reflecting on a little that I've learned about the Beaufort Sea, in the time I'd worked in the western arctic; and I had known that very often in a ten-year cycle of the sea, seldom--that you may seldom have two years that are quite comparable. And faced with a situation like that, it seemed incongruous to me to talk about a one year

program; and yet there was something which was pressing, and which preliminary commit ments had been given. In that kind of a context I talked about a three year program being a minimum. I guess it was in a hope that the law of averages would sometimes work out favorably, so that a reasonable average for sort of that ten year cycle, might be struck, during a three year study.

Q So you begin with that view, and then you say that, as I understand you, that that program, as it was carried out, should become part of a two phase program that you referred to, which I understand to have as one part basic environmental research, and as a second part environmental impact research. Do I understand you correctly as to that?

A That's correct.

Q And you then conclude your evidence by saying that there is a ten year gap between development that is proposed and technology capacity. Is that a fair summary of your ten year gap statement?

A Yes, and I think that's fair. The industries themselves, I would point out, have been talking in very comparable terms, and this is part of this dilemma. I had learned a lot more in the interim about complexities and for instance, I have before me a paper that was presented in 1973 at that congress that I referred to, the offshore congress, in Paris, when they considered offshore drilling; and in it it has a table which suggests that from the time

that you start a research program on the environmental area, until the time that you can begin the first exploratory drilling, is a minimum of 7½ years should be involved; and in talking about an absolute minimum in terms of the pressing reality, and in terms of something that would really be desirable in society, and considering the day to day problems that were faced by the Beaufort Sea Commission, I had to say, I felt that in fact, if we were really talking in terms of an optimum situation, it would in fact, from the time that you started this work, it would be pretty close to a 10 year period.

Q Yes sir. The work though as I understand it, you see as having to proceed along 3 research fronts. A basic environmental research front, an environmental impact research front, and a technology research front. Those are the 3 fronts that have to be moved against. Is that correct?

A What did you list as the second one?

Q Environmental impact.

A Where are you drawing that specifically from my evidence?

Q Well let me ask you to turn to the top of page 25, where there you refer to a two phase research program; the first phase being a carefully developed long term program of basic research, and the second, which I read, perhaps inaccuarately, to refer to an environmental impact research program, or phase.

A In my testimony when I reworked it for presentation, I stated it this way. In my view such research should have two phases: one, a carefully developed long term program, and then at the end of Beaufort Sea environment, I placed two. There is also a need for a more specialized environmental impact research program, and the highest priority would be research which is designed to identify or predict potential problems, which could result from the various aspects of petroleum development.

Now in that impact discussion, I included the idea that the monitoring would be included as part of that. I have a rather strong conviction that it's very important that we learn from projects which are ongoing, both for the benefit of that area and for the benefit of other areas which may be developed in the future.

So I in fact had identified two, but I had included environmental impact research program as including a major monitoring program as well, so possibly it might be reworded to say there was three.

Q Yes, without breaking off the monitoring from your environmental impact research front, I refer to a third necessity as being research to overcome the technological hurdles that you say are presented to the industry. That is, you've told us that in your view there is a ten year gap between what they want to do, and their know-how.

A If you cared to classify it that way, I would be quite satisfied to say the technological

one is the third.

Q Yes. And you'd admit of course that there has be work progressing on all three fronts, the basic research front, the impact front, and the technology front.

A That's correct.

Q Your concern, I take it, as to where we are at the moment, is that there is not enough done on each of those three fronts?

A One of my concerns in the technological area has to do with the fact that even some of the systems which appear to be on the horizon, are no being put even to the prototype stage. In publications, for instance, one of the background publications that deals with this; there's one in the Petroleum Engineer of January 1975, and it's by Dr. Gordon Jones, president of Global Marine Arctic Ltd. of Calgary. The article is titled, "Arctic Poses Extreme Technical Challenges", and then he talks about the various possible systems. One of the ones portrayed is a self-contained arctic cushion air drilling system, and he infers that this system essentially could be developed, or could be taken to the prototype stage.

But there would be a couple of years construction time even there, and so this concern is that we don't go to the experimental stage. We talk about all the development we're going through, but we won't actually go to the experimental stage of testing the prototypes.

I was getting into the same

type of thing a bit yesterday with the monopod. It has approval in principle. It would be a number of years in a testing phase to determine its value; so the concern there, and the reference to time, is a complex one which deals both with research and with the fact that we don't want to seem to want to get on to developing prototypes, so that we could really get into the applied part of the research.

Q Yes. You've no doubt though sir, that there has been, up until today, research and experimentation to some degree on all three fronts, that we identified: the basic research front, the impact front, and the technological front. No doubt in your mind that we've gone some distance down those three roads, but not far enough. Is that your position?

A Yes, that's my position. I think we just haven't gone nearly far enough in the third phase, that you've listed as "3".

Q Well, now you're anticipating my next question. I'd like to ask you to compare, if you will, our present position on each of those three roads. Are we least adequately prepared on the technological front, or the environmental impact front, or the basic research front?

A Well, I suppose I would be glad to jump out in the middle of the lake and attempt to deal with that question. I would like to call attention to the fact that I refer to my work as investigative journalism, and perhaps too,an application of political science techniques, and I

admit to not being a technical expert, in terms of offshore drilling. In fact, I consider it an incongruous situation, that this type of question of necessity is addressed to an ecologist, so that some information can come before the Commission. I admit to a very great sense of humility about my capabilities of dealing with that question.

Now, if we talk about offshore drilling systems, the ones that are far in deep water areas, there was a two year period required for the construction of the drill ship system, and that happened, that two years was required, when the the actual hulls were already constructed. These were war-time hulls that were in mothballs, that were purchased by Dome petroleum, and adapted to drill ships, and that required a two year period.

Now there's nothing significant about that technological development at all. It is a traditional approach to the use of drill ships. It's not dynamic positioning, and the one thing that they did was to ice strengthen it. So as I said yeaterday, sir, it could deal reasonably well with the Beaufort Sea in summer. So just to go to a very traditional system, there is two years required.

I referred yesterday to the statement by the official of Shell Oil, again at that international congress in 1973, which said that when they came to look at this, that none of the background information associated with design, that was needed for design, was available to them. And so, I interpret

that s meaning that considerable load time is necessary to go into a system that is really capable of drilling at any period of the year, beyond the open window, and the oil companies tend to refer to the periods that they can work as the open windows. And the open window in the Beaufort Sea is about four months.

So I would argue that a system that is only capable of dealing with that open window, and when that open window may not exist every year as in fact it didn't in 1974, then we're almost at square one in terms of working on a technological system, that is capable of dealing with a marine environment. So in the deep water areas I say, it's obvious that there's a lot of time involved. Whether the ten years is a critical - I didn't have a design. I was going partly on this type of paper to gain understanding, but it seemed under those circumstances to really deal with the Beaufort Sea beyond that 190 to 120 day window that 10 years was a pretty realistic time and we're not very far down the road, and I think in that respect, that is probably the lowest level in terms of our progress.

Q If I asked you to rank our shortfalls on the three fronts on a scale of one to ten, as we say --

A Well I'd say that in the case of dealing with the offshore -

Q Dealing with the offshore you would rank technology lowest on that scale.

A Yes, I think I would be

inclined to rank it pretty close to square one, perhaps square two, because at least we've been talking to them, at least we have papers like this now, that are attempting to talk about them. But certainly not very much beyond that.

Q And using the same scale, I take it you feel that the present state of environmental impact research is not quite so inadequate, and perhaps would rank higher on the scale.

A I think it is somewhat higher, yes, because in some of the areas, for instance, in the interest of the native people, we've had fairly good research programs going; apart from this, on seals. At the arctic biological station there have been a continuing program, an international program, on polar bears. The Canadian Wildlife Service as part of their research have had some research going on a number of the, particularly snow geese, and some of these forms. The Canadian Wildlife Service had a fairly good study of the murres. This doesn't apply much to the western Arctic, but that was done in the fifties and sixties.

So I think probably in the cases of - but the areas of great shortcoming, on say in this same area I'll talk about, these are the ones where there was possible - but the areas of really great shortcoming in ecological areas as I see it are in the areas in the lower levels of the food chains. I think the reports from the Beaufort Sea study that deal with phyto and zoo plankton, and their distribution and not only their distribution, but even the species and

their inter-relationships; none of these things, this is a very gross area of our lack of knowledge.

Q Yes. You're now speaking though of research in what I've defined in the basic research, rather than the environmental impact research.

A Yes.

Q If I'm right sir, before you get to that could you put the present position of environmental impact research on our scale of one to ten, having acknowledged that we're not quite so deficient in that area as we are in the area of technological research?

A Well I don't see - if we had basic research that was adequate, environmental impacts research would start there, we wouldn't do any so-called base line research at all. We wouldn't have to. We would just use information that existed. So it's very difficult to come to terms with your question when in fact we have very large inadequacies in the basic area, because it's on the basic area that impact assessment must be based. I find it very difficult to separate those two.

Q Okay, I understand that. Let's then go to the basic research front and let me ask you the same question in connection with it. Where do you put our present position in basic research on a scale of one to ten? I take it from your earlier answer that you feel there are fewer inadequacies with that than there are with our technological research position.

A I think you'd have to break it down into a few subsections. Some of those

obvious important species that have had continuing research programs--polar bears, seals, some of the snow geese, some of the sea birds--in that area I think that we're up around square four or so, perhaps even a little higher, I'm not sure, but we're there. In the case of fish, for instance, we're awfully close to square one. For instance, Tuktoyaktuk has been dependant on an interesting harbour fish, they do a lot of netting in the harbour. When I was here with COPE I tried to find out what we knew about the base of the Tuk fish resource, and I dropped into Yellowknife at the Fishery Service Office and I found that basicly there was virtually no background information on the Tuk fishery. The preliminary reports for the Beaufort Sea project are just beginning to identify the coastal areas as being of key importance. As I mentioned yesterday, the lagoons and bays and things as being very important to nurseries. So in that aspect of our knowledge, we're very close to square one or two.

In dealing then when you get down to the basic elements of the food chain, the phyto and zoea plankton and so on, the reports by Dr. Granger and Dr. Percy and some of their associates at Arctic Biological Station, I think, will show clearly that that is a square one situation.

So it ranges from I would say, in that area, from roughly a one to four, one to five, in the best study situation.

Q But overall, your position

is that our inadequacies there are less stark, than our inadequacies on the technological research front?

A Yes. And one of the things I'm counting on in that is the fact that we can make up some of these. In the case of the technological side, you can't start until your technology has been developed and your system has been constructed. But in the case of basic research, you can pick up some of the inadequacies as you go along, and that's a very important consideration.

Q Now sir, having asked you to compare where we're at in these three research fronts, you're an Arctic ecologist who has obviously given a good deal of thought to those research fronts, I'd like to ask you if you would to go through each of the three fronts with me, and give me your opinions, if you have any, as to the nature in a little more detail of the study programs you see as necessary bring us from the square we're at to the square you think we should be at. Let me begin with the basic research front, and ask you if you can define for me the scope of the research program that needs to be done, in your view.

A Are you asking me here to deal only with the biological side of this equation, because I really simply cannot deal with the physical side. That's the realm -

Q By all means. Limit yourself then to the biological side.

A Well then I would remind

you also that I admit again, you referred to me as an Arctic ecologist. I have worked in the Arctic on large mammals, I have attempted to gain understanding. A great deal of my understanding in the case of the Science Council study came through the eyes of associates. In a job like that, as in many elements of the Commission hearing, your skills have to be as a brain-picker. You have to be able to gain understanding from other people, and with that recognition, I guess I would be glad to attempt something.

I think in dealing with this biological area, we're always attempting to find out what our key limiting factor is in a system. Sometimes there's no simple ones, sometimes there can be sort of like key logs in a log jam and could be very very critical. And so, in gaining an understanding of the interactions of a system, it's a real effort to try and understand what kind of limiting factors you might be involved with.

If I might digress slightly to provide an example of one of those. When they were doing the polar bear work in the Hudson Bay area, they found that there was a very important polar bear denning area, in which they wanted to do winter exploration, and it had the potential for great problems. Bears going into sites and I suppose coming out after the young were born, and so on. In that situation, they were able, just by simply having a detailed understanding of the importance of an area,

just to avoid it at a critical time, and so avoid the problem.

So in looking at any of these situations, you're trying to get that kind of understanding, so that through the use of this understanding you can mitigate, or prevent things from occurring. So, in looking at this whole thing from the point of view of limiting factors, you need to understand whether there are important things that could be lost.

In my own field, for instance, I've studied wolves for many years - or on Baffin Island, the presence of caribou is absolutely vital. You can't have wolves on Baffin Island unless the caribou herds are maintained.

I think it's possible that in the marine environment, that there may be key factors involved that might be vital, for instance, to seal production, and I don't think that we understand the intricacies of the inter-relationships within the community, or the details of the workings of the community, and the different stages of food chains. We can't really pin any of those things down.

So this is where I see the problems involved. You can identify nursery areas and feeding areas fairly quickly, but to identify real problems like that, that's where where you get into the critical time factor.

And so I would say, to sum up and answer your question as directly as I can, I

think it's in this whole area of trying to sort out community inter-relationships and food chain relationships, that are very important to a reasonable understanding of the workings of the Beaufort Sea eco-system, and it's in trying to unravel those things that a lot of time is likely to be involved.

THE COMMISSIONER: Hasn't the experience in the north been, Dr. Pimlott, speaking generally, that the research on the nature of eco-systems is not usually carried out until a resource is discovered and it becomes apparent that something has to be learned about the eco-system before exploration, whether it be for oil and gas, or for lead or zinc, or for some other resource, occurs?

A This has been very much the case. In the paper I referred to yesterday by Dr. John Sprague, I didn't refer to it directly, but the follow-up that I referred to yesterday was a paper by Dr. John Sprague, prepared for the Canadian Arctic Resources Committee workshop in 1972. The purpose of that workshop was/to try to see where we stood with respect to things like this. He pointed out that at that time the principal work on the Arctic marine environment was constituted, was being done by nine people and those people also had the responsibility for marine mammals on the east and west coasts, as well as in the Arctic.

I think that this reflected, in part, a fundamental bias that then existed in the Department of Fisheries, which then became part of the Department of the Environment, because the pressures

on the Department had always been to serve the interests of the fisheries on the east and west coasts, it was reasonable enough; and so the Arctic section of their work always lived a very starved existence, and I think that it perhaps was inevitable in our society, I suppose, that this is what happens , but it certainly was the case.

MR. GOUDGE: Dr. Pimlott, in describing in general terms at least, the outline of the program you see as necessary, on the basic research side, you deal with inter-relationships, and I take it that the problems that you describe cut across species, they apply to a variety of species and the inter-relationships between them.

A Yes, that's correct. An attempt is being made, for instance, to get over some of these problems. In our application of science, we've been very inclined to work as single scientists, we're not very anxious to get together and work with somebody else. That type of thing is being broken down by the Beaufort Sea project approach, and that's one of the reasons why I said yesterday that I think we have to more or less force scientists to come together and work in a common framework.

There's been some work on this before, for instance, there's been very close relationships, I believe, between the people who studied polar bears with the Canadian Wildlife Service, and the people who studied seals, from the Arctic Biological Station. So there have been cases where it has been

gradually coming about, but it's something which scientists need to be clobbered on a little harder to get that kind of group working relationships going.

Q Well, given that the program you describe is of the nature you describe, and inter-disciplinary, if I can use that phrase, in your view whose responsibility would it be to carry it out? Industry's, or government, or shared, or what?

A I've thought a lot about that, in the course of trying to do a chapter on research in the book which I referred to yesterday, "Oil Under The Ice", and it seems to me that when you check all along the line, that industry performance is basically better than government's, and I think that in view of this kind of lack that I just referred to, in the past, in terms of developing background basic research programs, I really feel that there should be special allocation on the government's side, for the basic research. I feel that the monitoring and the impact assessment should be funded by industry. I'm not satisfied to have that kind of research done under an APOA type of arrangement, it just simply doesn't work out, for you get studies being commissioned by two consultants under proprietory arrangements, where the information can be held secret for five years, and which terms of reference can be given which are not broad enough.

So I believe, to answer your question directly, that the basic area should be the responsibility of the government; that there should be

a catch-up program in the Arctic, and the monitoring and environmental impact research should be basicly funded by government with some kind of an organization which is responsible for deciding what needs to be done, and for allocating the contracts.

Q Did you mean to say the environmental impact studies should be funded by government, or by industry?

A By industry.

Q Well let me come to the environmental impact side in a moment, but to complete the basic research side, have you given any thought at all to the cost of the program that you advocate?

A No, I haven't. I'm aware of the fact that Immerk cost 9 million dollars to drill, and the drill ships systems/I think, are costing 130 million, and so -

Q It sounds like you're leading up to a large number.

A No, I'm not going to state the number, I'm just going to say that I can't see, under any reasonable system, that the money that's necessary for research should in any way limit, considering the scale of the expenditures, that are necessary.

Q Do you have any ballpark that you can place it in? That is, are we talking about a million dollar program, or a 50 million dollar program, or what?

A Well,the Beaufort Sea

research program was originally funded for about 5 million, and according to Dr. Millen, it has cost, if you put all the things together into a real cost, it's come up to about 12 million. And so I think that in view of say a ten-year research program that dealt with physical and biological environments, something in the order of the expenditures that are being allocated for the western part of the Beaufort Sea, something of the order of 40 to 50 million dollars would probably be required.

You have the very high costs of providing ship services, and so on, and it does come, it's expensive research. You need aircraft, you need ship services, and I think 40 to 50 million dollars is certainly ~~somewhere~~ in the ballpark.

Q And this is for the basic research program that you speak?

A No, I was thinking in terms, at this time, that this would be the combined -

Q Basic research and environmental impact research?

A Yes, 40 to 50 million, within that.

Q Well, let me move in a little more detail then to what I've described as the second front, that's the environmental impact research front. You, I take it, link that closely to the basic research front?

A Yes, because I say that, as I said, what you do in environmental impact research

depends a very great deal on what your background -- on the background knowledge available to you. A very large part of the Beaufort Sea research wouldn't have had to be done if the government had had an accurate research program in the north, because we would have known a lot of the things about - we'd/have known where the Tuk fish come from and what are their important nursery areas and so on.

Q Well on that side of the research picture, at the moment, have you given any thought to the nature of the program that you advocate as necessary, to get us where we should be?

A No, I've thought only in terms of some principles. For instance I had the opportunity to examine some of the environmental impact assessments that have been made, and I think that they have been made under very restrictive terms of reference, and very restrictive budgets.

For example, I studied in some detail the impact assessment that Pan-Arctic submitted for offshore Hecla, and I was absolutely appalled by it. I think I said at the time, and I think it was a realistic statement, that I could have given, expected a fourth year ecology student working with me to have done a comparable job, for a one-course credit, perhaps even for one semester. It was a library research, it was so filled with vague generalities and inanities, that it was incredible. And then I saw others that were supposed to be improvements, and they were very poor. So the principles that I have been thinking about

have been that somehow, the environmental impact assessment must have a moderating body of some kind, that decides what kind of impact assessment needs to be done, how much money will be expended on it, and what the terms of reference will be. It just cannot continue as a realistic process, if industry is able to establish the terms of reference and the limits of funding for the projects.

Q Well to I understand you to imply that that moderating body, by which I take it you mean a body directing the environmental impact research, is that body in your view required to be a government body?

A Yes, I have long maintained that there should be a strong separation in government between the agencies of government which regulates the things pertaining to the environment, and that which promotes the development, and I think that this function could well be performed by some kind of a body either constituted by or as part of Environment Canada. It is not logical for it to be a body in a department which has the role of promoting the development of the resources.

Q You begin with the proposition, as I understand you though, that it should be some government body as oppossed to a non-industry private body.

A Yes, I have a strong respect, I think, for the system, the government system, the democratic system in which we work, and I think that

our politicians should ultimately be responsible for things that pertain to the protection of our environment. We should be able to call them to task. And so I tend to think that that's where the responsibility should lie.

Q Yes sir. Now that's principle number one. Any others?

A Well I guess the second principle relates to what I said before, is the work associated with environmental impact assessment should look strongly both to the present and to the future. It should help us to do as much as possible to prevent problems with current development, and to mitigate those which may occur.

It should give us the insight and the understanding so that we can do a lot better when we're working on ones a little way down the line.

Q Yes. And without fleshing out the particulars of the study, or the studies you see necessary, to get us where we should be on the environmental impact front now, those two are the main principles that you would advocate as the foundation for the research.

A I think so. I'm not very good at instantaneous thinking out of these things. I tend to be a strong bull session man, who starts to develop ideas and then starts testing them on people. So if you ask me again a week from tomorrow, after you've stirred my thinking up to be more specific on it, I probably would throw a few more curves, but I don't

have many instant answers at the moment.

MR. BAYLY: We will probably be bringing Dr. Pimlott back so he can answer that question.

A Don't threaten me now, Mr. Bayly.

THE COMMISSIONER: Maybe you should bring forth your ecology students.

MR. GOUGE: That's right.

Well sir, let me ask you then, moving to the third area of research, and perhaps you feel reluctant to answer any questions on it, and say so if you do, but have you given any thought to the general scope of, and perhaps even the particular parts that would make up the technological research program that you feel has to go on over the next decade or something less.

A The really big bind, as I see it, in the technological research, has to do with drilling in moving ice. There isn't anything - it seems to me that there isn't any really big problems associated with getting a drilling system that can work in winter in the Sverdrup Basin.

Pan-Arctic's platform moved; they had an allowance of twenty feet, and apparently it only moved about eight in, I don't know how many, 5%, I think they were drilling in 450 feet of water, so they could tolerate 5% movement, and they had less than that. So, I think in the Sverdrup Basin, and in the sure fast ice areas, these are areas where the technological

problems can be solved fairly quickly, if there was really a mind to get at it and to invest the capital that was necessary.

Q We'll be coming to that in a moment.

A But it's the moving ice, that I don't see any answer to in my limited understanding, and some of the things that are being said really frighten me about that moving ice area. At the offshore drilling meeting, senior vice-president of Global Marine said that,

"We have given at recent dates some consideration to actually operating or trying to determine the feasibility of operating on the polar ice pack."

Q When was that meeting sir?

A That was December, 1972, a paper called "Global Marine's Drilling System For The Arctic Offshore." It was by R.B. Thornberg, senior vice-president of Global Marine; and that's the area when you start talking about the polar pack, and even the ice in the Beaufort Sea, it seems to me that in there, there is no immediate answer, and I haven't been able to see any possible - I haven't been able to learn of any possible approach to the solution of that problem, and I think that is the paramount one.

Q And I take it that you see that as the paramount problem because of your concern over blowouts from drill ships that may require relief well drilling from the pack ice?

A Well, it's the production

systems as well. How do you service production systems? If you get 150 miles from shore, it's going to be very difficult, I think Mr. Shearer brought it out yesterday, of getting that petroleum, whatever form it's in, to the shore without doing some kind of treatment; and we have a long long way to go, in even being able to look after some kind of a leak in a system like that; during a difficult time, during a breakup period, during a moving ice period.

So I think that the problems there are not just associated with exploratory development drilling but they are very, very big in terms of both production and transportation.

Q Yes. Now sir, I take it that this particular research front, is in your view, the responsibility of industry, rather than government?

A Absolutely. The only question I've had in my mind, is whether or not government has some responsibility, given that it has encouraged industry to take out exploration permits in these areas. The first permit in the Beaufort Sea was given in the early 1960's, the bonus blocks were given out in 1968, and given that the industry was encouraged to get out there and to spend a lot of money, I think the question needs to be faced as to whether or not we have some responsibility to advance the technology, to move ahead more quickly on this front. I've asked myself that question a lot of times, and I certainly wouldn't be the one that screamed very loudly if a decision was made that there should be

government participation, because as I say, I think the government has a primary responsibility for encouraging industry so strongly to take out exploration permits.

Q Well what then, is your answer to your own question, is it that there is any other responsibility for this program besides the one falling on industry?

A I left it up in the air because I never answered the question, I've simply said that it has come to my mind many times, and I don't know. I think it would be reasonable to consider it at least.

Q Yes. The primary responsibility, however you answer your question though, remains with industry.

A That's correct.

Q Now, given the three research areas that you've identified and spoken your concern about, if you take them all together and if you assumed research moving forward on those three fronts, can you tell me at all whether there would be a risk reduction in terms of what might happen to the environment? I take it the whole point of these three research front movements is to reduce risk?

A What is the question specifically?

Q What I'm interested in is, is it possible for you identify, assuming these research programs to move forward as you would like, over the next decade, or something shorter, what order

of magnitude in risk reduction are we talking about?

A Well, I don't know. If we could operate in the Beaufort Sea on even a nine-month basis, in case of an emergency, it would be very considerable; because then in the case of a blowout we'd have a very good chance of turning it off within two to three months. And now, Dr. Millen suggested, as I said yesterday, the potential time that a blowout could blow is two years, up to two years, or conceivably longer.

So if we had this capability of going out there and being there for six to eight months, it would be very, very considerable reduction in the magnitude of the risk .

Q It doesn't bring the rest to zero, obviously, there will always be a risk.

A Absolutely. I presume we're dealing now with societal trade-offs.

Q Yes.

THE COMMISSIONER: Dr. Millen is head of the Beaufort Sea project?

A Yes. And he just issued his summary report which has been circulated by the Minister of the Environment, or the acting Minister.

MR BAYLY: He is the witness that we will be calling next.

THE COMMISSIONER: You will be calling Dr. Millen.

MR BAYLY: Yes, you will be hearing from him the week after next, I anticipate.

THE COMMISSIONER: The week after next?

MR. BAYLY: Yes. We will be distributing his evidence hopefully before people disperse this week.

MR. GOUDGE: Mr. Commissioner, there seems to be a groundswell for coffee. I've reached a break in my cross-examination. I have somewhat more, not too much, but some more than perhaps the coffee wagon can sustain.

THE COMMISSIONER: Oh, very well.

(PROCEEDINGS ADJOURNED FOR A FEW MINUTES)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: Mr. Goudge?

MR. GOUDGE: Yes sir, just a couple of more areas, if I might. Dr. Pimlott, one of the things that you expressed most concern about in terms of offshore drilling is, as you put it at the top of page 27 of your prepared evidence, "the problem caused by an oil blowout in offshore drilling." Now, let me ask you whether you're aware of any statistics that bear on the frequency of blowouts, generally, or blowouts in offshore drilling?

WITNESS PIMLOTT: Yes, I don't have them immediately at my command. They're -- the statistics are covered fairly well in three publications. The two I mentioned yesterday and then there was a further conference and I've forgotten the title of it. I think I have it. I could dig it out in minute, but there was another conference having to do with marine oil pollution questions that dealt a lot with offshore operations that was, I think, sponsored by the National Science Foundation, again. These three publications do give quite a lot of statistical background on spill frequency. Dr. Millen in his paper suggests a blowout frequency of about one in a thousand and in trying to check that out, I came to the conclusion that he was sort of given a best estimate and that some of the statistics for other areas that I looked at, although I don't have the background data immediately, led me to conclude that it could be argued that one in 500 would be much closer to a frequency. But those data are pretty well covered.

Q Let me stop you there for a moment and ask you just so I understand it. When Dr. Millen says "one in a thousand", can you tell me, that's one in a thousand what?

A I gather he means one in a thousand wells drilled.

Q I see.

A And there's another question, of course, there seem to be always those are the statistics. Another very pertinent statistic that seems to me should be calculated is, what is the percentage of successful wells where oil or gas is actually discovered? What percentage of those blowout? It seems to me that that's more relevant or just as relevant as the percentage of total wells.

Q You understand, Dr. Millen's statistics to relate to one in one thousand wells, whether they are dry or not?

A Yes.

Q Yes. Now, you said sir, that in your view the proper or perhaps the more pessimistic view would be one in five hundred?

A Yes, I think so.

Q Let me ask you how you come to that statistic and why you differ from Dr. Millen?

A Well, it had to do with the statistics. I think they're right here.

Q I've stolen one of your books.

A If you will let me take a minute, I will quickly try to --

Q Well, I would be interested to know the basis on which you say the more realistic figure might be one in five hundred wells drilled?

A Well, the statistics as I recall them were, between --

THE COMMISSIONER: Excuse me, Dr. Pimlott, why don't you just take a moment and dig them out. We have --

MR. GOUDGE: I have got one of your books, sir.

A I will check this one first. I have a paper here that is a rather interesting one that deals with these statistics and the section I referred to is in the book "Energy Under the Ocean" and it starts on page 285 and it is called, the section is "Drilling Accidents".

Q Just so I will recall it, sir, "Energy Under The Ocean" is what?

A It is a publication that was prepared. It is a technology review of offshore drilling in the outer continental shelf and it was prepared under a grant of the National Science Foundation by a group, an interdisciplinary group at the University of Oklahoma. It was one of the first background documents in or one of the first background projects leading up to an extensive leasing program for U.S. outer continental shelf areas.

Q And what is the date on it, sir?

A It is, I think it is 1970, I believe it is 4, 1973.

Q I am sorry, you were about to refer to some statistics that, at a given page.

A The paragraph here. "An examination of the drilling and blowout rate over the period, 1953 to 1971 reveals that there were two time periods during which most blowouts occurred. 1956 to '60 and 1964 to '69. During these two periods the percentage of new well starts resulting in drilling blowouts was a little less than 0.2%," and so that would be about 1 in 500 for that period.

Q Yes, I understand.

A One percent would be one in one hundred and .02 would be -- we're dealing in that statistic, that is one statistic which states that.

Q Yes, he quotes there though --

A There it goes on to say --

Q Just so I'll understand before you go on. That is for the two worst periods.

A Yes, but then they go on to say, "there appears to have been no decrease in the percentage of blowouts over the years. If only blowouts from wells producing oil and gas are counted for the period, 1964 to 1971, the percentage is 0.3%."

Q Yes. Now, do you know whether, I am just interested -- are those statistics on a world-wide basis or on what other basis?

A I believe these were all U.S. statistics that they were dealing with.

Q Do they include both onshore and offshore statistics?

A No, those were just offshore. There is a separate paragraph here which indicates which gives the statistics for onshore and which indicates that there was a lower rate for onshore and it is almost a factor of 10, I believe, in the difference.

Q So what you are saying is that for the two time frames estimated, 1956 to '60 and 1964 to '69, the experience offshore has been a one in 500 well blowout ratio.

A Yes.

Q I might say that one of the things that makes it difficult to just use the ordinary statistical procedure is the fact that there seems to be very often this clumping effect with periods --

Q This what effect?

A I called it a clumping effect. A period of time when for some reasons I don't understand, there is an increased frequency of accidents. There is an article in "Offshore" magazine which deals with storms which indicate that in dealing with mishaps in offshore rigs and that there are some

periods of time when there is an increased frequency of accidents so it is -- when you talk about one in a thousand, it seems to me that statistically and I don't pretend to be again a statistical expert, but when you are dealing with a situation where you get variation and not a uniform periodicity then that is a whole new ball game.

Q Yes, I see.

A Dealing with the statistics, if you are -- you seem to be interested in those -- in the period from 1955 to 1974, there were listed that there were 95 serious rig, offshore rig mishaps in the, on the world scale and weather caused 46% of those and blowouts caused 22%. 21% of these 95 rig mishaps that occurred between 1955 and 1974 resulted from blowouts and that is based on an article in "Offshore" magazine and it is called "Storms are a Major Cause of Mobile Rig Mishaps Offshore". It was in June 5, 1974.

Q Coming back to the one in 500 risk factor, if I can call it that, would it be your opinion that with advancing technology that figure would be elevated to something like Dr. Millen projects or beyond one in a thousand or perhaps one in an even larger number of wells drilled?

A No, I feel very uncertain because about that, granted that there is improved technology or apparently improving technology but there is all of the unknowns of operating in a very harsh physical environment and I don't see how -- I don't

feel prepared to make any blanket prediction that is valid. I don't know.

Q Well then, let me ask you the next question and you may well decline to answer it as well. Is there any threshold risk level that must be reached before, in your view, this kind of drilling should be permitted, that is, I take it, implicit in your evidence is that the one in 500 statistic is unacceptable from your point of view. What would be acceptable?

A In my testimony -- the way I ended my testimony, I said "I do not consider that it is in the national interest to put at risk the natural resource base of northern natives peoples and the Arctic environment in this way at this time." And implicit in that is that I, the feeling that I don't like acting or pretending that I am God in trying to say what society should do. What I feel very strongly about is that we should have a much more rational approach to considering the options that are open to us and to evaluating the various areas of societal needs. I want society, I want to do what I can to contribute to society doing a more comprehensive job of coming to terms with this. But I don't, I am not prepared to set a Doug Pimlott standard for what should happen in the Beaufort Sea or what level of risk we should take. I hope I can contribute to us doing more about it but I don't try to set myself up as God in that way.

Q Are you prepared though

to say that the present risk standard that you have advanced, one in 500 should be deemed unacceptable?

A Under the present framework, yes, I consider that to be so.

Q Yes.

A In both --

Q Having said that though, sir, aren't you obliged to say what risk standards you would see as acceptable?

A No, I'm not because if we had come to -- if society by some more rational process, if even the members of the House of Commons had gotten together and said, "look, we must have this oil for this reason," I think I could be convinced. Maybe we do, but we have not gone through any rational approach to deciding about whether this was a good option for us at this time, either in terms of the other areas of societal concern, in terms of the needs of the next generation for petrochemical products and that is why I said "in this way at this time." Perhaps it is an acceptable, if our needs are great enough. I am impressed by the fact that five years ago the industry was telling us that we had oil and gas for a multiple of decades and I must confess that I am a doubter, I don't know whether the industry is giving me, selling me a bill of goods now or not. I would like to know that. And I would like to see our society answer some of these questions so those of us who are concerned would understand what

kinds of trade-offs we logically should be willing to accept.

THE COMMISSIONER: Well, they said we had 300 years of gas and a thousand years of oil. Now, it appears they do not claim to that same view. But the National Energy Board is currently holding hearings at which they are examining the questions that you have raised. They are important questions; that is, do we have to bring this gas from the frontier. That is, do the needs of southern Canada require it and I have said that the Cabinet will, at the end of the day, have my report before them which will indicate the impact that the pipeline and all that it will mean, would have on the north, and at the same time they will have the Energy Board's report which will indicate what the supply of gas may be in the Western Arctic and what the demands of the Canadian market and perhaps the U.S. market are, and then they will have to decide. But you may say that all of this will come later than it should have, but that appears to be the kind of decision making process the government has sought to organize.

Certainly, if you compare it to the decision making process that has attended large scale frontier developments in the past, it must compare favourably, at least, in some limited respect. I hope it does after all this. At any rate, I understand the point you are making. I'm just introducing a word of --well, praise is too extravagant an expression when dealing with the Federal Government

but introducing a suggestion that they have been thinking about these things in an organized fashion that should be taken into account. However, you carry on. I just felt obliged to say something on behalf of the Federal Government. I didn't think anyone else would likely do it, so I did.

A Yes, I hope that there will be room to praise the way the National Energy Board and your report are considered. It would seem logical to me in terms of both the short and the long term questions that are answered that these two reports should lead to a White Paper telling the country what kinds of decisions the governments have made and why it felt compelled to make them. I think that one of the critical questions having to do with the considerations that Mr. Goudge is raising, is whether or not we can get through the short term period of energy transition without using up all the petroleum resources or not. It is very critical between now and the year 2000 or 2010, and it may be that we cannot make these transitions without gobbling up all of this. Well, that is the kind of things that I would like the government to tell me and then I would certainly say, well, under this condition perhaps, we don't have to or perhaps we do have to consider the risk components in a different light.

But these are the things that I think in any kind of a reasonable approach to democratic government that those of us who are sitting back paying the taxes should have some

capability of understanding and the decisions for this should not be made in camera, but I really, I would love to praise for a change but --

THE COMMISSIONER: Well, we will all look forward to that.

MR. GOUDGE:

Q May I move, Dr. Pimlott, really from the sublime to the ridiculous? I would like to ask you one or two more questions about the statistics that you have knowledge of. You have told us about your -- some of the statistics that relate to blowouts offshore and I understood you to say that there are statistics available for blowouts onshore and they show a substantially reduced frequency of blowouts onshore.

A Yes, that is --

Q Where are they in that book?

A Page 268, the last paragraph of that drilling accident section that I referred --

Q And that is the same book, for the record, that you were referring to a moment ago.

A Yes, that's right.

Q Now, are there statistics in that book or elsewhere to your knowledge that relate to the time taken for the drilling of relief wells in a blowout situation?

A No, we have some Canadian statistics available in terms of King

Christian Island and I have -- I'm not sure I totally recall exactly where that piece of paper is, but I do have the article here on the table which discusses the time frame which is required to drill the relief well for King Christian Island which is a land operation. It was very considerable. It was a land well and as I recall, even there, it was a six-month operation by the time the equipment was assembled and all of the problems went through but I don't -- I am not aware of those statistics. I am sure that they are probably available in one of these areas.

Q Particularly, perhaps in relation to offshore drilling off the Gulf of Mexico for example?

A Yes, and for all of the Southern United States, I think, they would be available.

Q Dealing with that, do you know whether there is any requirement or practice that requires the presence of a second drilling platform, back-up drilling platform?

A Well, when you get a place like the Gulf of Mexico where you have a very large number of wells being drilled at any one time, they are always available and I -- the answer is no to your question. I can see the -- what I was starting to say was, that I can see the reason for it in places like that because there is usually a multiple of wells being drilled.

Q So, it is "no" with an explanation.

A Yes, that's right, yes.

Q Let me move then, if I can, unless you have not completed your answer, let me move to a matter of spills as opposed to blowouts.

A Yes.

Q On page 36 of your prepared evidence, you recite that statistics particularly related in the middle of the page to spills from platform drilling?

A Yes.

Q And do you have any views as to the transferability of those statistics to drilling either from man-made islands or for drilling from ships?

A I guess the -- probably the only view I have is that -- has to do with problems associated with, the likely problems associated with the incident and I am referring to the ice conditions that we have been introduced by Mr. Shearer and which I have referred. It would seem that even the same number of spills could probably constitute a larger problem in the Beaufort Sea because it would be much more difficult to deal with and because we probably couldn't get down say to a leaking well head if it occurred at the break-up or the freeze-up to repair it, so I'm inclined to think that the same number of problems would create a greater total problem but I don't have any --

Q I understand your views on that score. I was simply asking whether you had any opinion as to the transferability of the numbers.

A I think that -- my guess again would be that they would be conservative for the Beaufort Sea because of the problems associated with brittle fracture of metals and things like this at low temperatures. I am inclined to think that they should be considered to be quite on the conservative side, but again I am no engineer and I'm not sure whether logic takes us very far.

Q You say though, at the bottom of page 36, that one of the difficulties with the spill problem is the enforcement aspect of it, the problem of prosecuting offenders. I wonder if you have given any thought to more effective ways of enforcing spill, anti-spill regulations.

A No, it is a very difficult problem. It is particularly difficult under a regulatory system where both the exploration and the environmental aspects occur in the same department and because the adequate emphasis is rarely placed on environment and when a company is in a difficult economic position, they will often, they will sometimes take the action and then face the consequences later as the lesser evil that they have to do with. There have been some examples of that in the Beaufort Sea and one particular one which I don't think I have the specific documentation but it had

to do with a company which was building an island. It found that its gravel source was inadequate and then it took action to go to an island and withdraw gravel without a permit and as I considered that action it was one of, as far as the company was concerned, it was a lesser evil. It faced the consequences rather than holding up its operation and I think that that applies -- when you have that kind of thing coming under control of a department that has the conflict of interest, it makes it difficult to get balance in regulatory process.

Q So that is one principle that you are suggesting in the enforcement of any anti-spill regulations, a separate enforcement agency?

A This is something which the industry doesn't want and you go back over the --

Q Well, is it desirable from your point of view?

A Very desirable, yes, I think it is one of the complications in industrial processes that has to be, that should be tolerated.

Q Are there any other alterations in the present system that relate specifically to enforcement that you would see as producing a more efficient enforcement of anti-spill regulations?

A I'm always distressed by the fact that things like this are kept secret and I feel very strongly that there should be more open process so that the problems which come to the surface are known to the public and I think in the

kind of the system that we live in, it works better when things are discussed, dealt with openly, so the second principle that I would enunciate would be this one of much more regular much more open process and particularly with respect to enforcement. The publication of all things that are associated with infractions of regulations.

Q Those are two basic principles that -- I take it those would be the two main ones.

A Well, I feel a little bit like that TV show where you -- I have gotten $10.00 and will I go for 20. The other aspect, I guess, that -- one of the other areas that I think is unfortunate and difficult -- it poses difficulty in, particular difficulties in the north, is the relationship between legislation and regulation. In our legislation, we give tremendous power to the administration to make regulations which are not subject to review at all by members of parliament, and that problem has been shown very clearly in the processes that we are going through with respect to the revisions of the oil and gas plant regulations. Here we have a process that is going on. There is a regular interchange between the industry and government of the revised regulations and seeking comments of industry, but the members of parliament have no access to this and the members of parliament will never have an opportunity, the appropriate committee of the Commons, will never have an opportunity to have any input on the

new oil and gas plant regulations and I guess the third principle if I were to enunciate it and I think I will stop at this one.

Q I don't have more than $20.00.

A -- Is that, I think there should be much more-in dealing with the basic legislation and regulations, there should be much more involvement in terms of political, direct political process. We had a conference in Ottawa early in December and one of the things that, we had an official of the Norwegian government there and the one thing that came out very strongly to my mind and to my inclinations was the fact that all major things associated with offshore development are made matters that are well-known by all Members of Parliament. I mentioned yesterday that the incongruity of a Member of Parliament for the Northwest Territories learning first about offshore drilling from COPE, rather than as part of his function as a Member of Parliament. And in terms of the whole question of dealing with these regulations, there should be much more involvement of parliament.

Q You are starting to like Mr. Diefenbaker, Dr. Pimlott. Finally, let me ask you a couple of questions relating to your evidence on page 20 of your prepared evidence, where you referred to the problem of abnormal geological pressures -- high geo-pressures. You expressed that as a concern in drilling in the Beaufort Sea and I take it your concern there is that there may be a coincidence between

the occurrence of high geo-pressures and a blowout.

A Yes. That is correct.

Q I wonder if you are aware of any statistics or records that relate to accidents caused by high geo-pressures.

A I tried very hard to become well-informed on the question of geo-pressures in trying to do the background research and I found it was a subject which wasn't well-covered at all and there seems, technologically, as I think Mr. Horsfield pointed out, industry is getting used to handling them but there is no question in my mind that they do pose a hazard, an additional hazard; because as they go from one layer, one geological formation to another they pose the threat of the system having to adapt quickly to changing pressures and it is a real intricate game that has to be played, because the balance, the pressures that exist in the formation have to be counterbalanced by the mud weight but they can't over-compensate with the mud because if they run into a weak geological formation, then they impregnate that formation with their mud and they lose it and so then they can get a rebound of the pressure and so they can't-- they have to play a very careful game and I think Immerk is the evidence.

Q Yes, I understand that, sir, and that is helpful but I am interested in knowing whether you know of any series of records on accidents due to high geo-pressures. No doubt, --

A They are simply, as far as

I am concerned, it is a question very much like seismic. It has never been adequately dealt with in the literature. I went to Ohio State University where there was supposed to be one of the authorities and I have the reference, I will just take a moment to locate the citation here, there was a paper by R.A. Deju. It was called"A World-wide Look at the Occurrence of High Pressure, High Fluid Pressures in Petroliferous Basins" and that was Wright State University, Department of Geology in 1973, Wright State University is in Ohio. That paper was supported by the petroleum industry, but it gave a rather interesting look at the problem as exist in different basins but it didn't give any statistics at all. There is just nothing given anywhere in the literature that I could discover and I went to Dr. Ken North. I had him criticize my original manuscript. I asked his advice and he is a petroleum geologist and he couldn't identify any other literature. In fact, I had encountered, dug up some that he was not aware of. It just doesn't seem to exist.

Q I take it though that you acknowledge that any risk or any increased risk presented as a result of high geo-pressures is to some degree at least, mitigated by what you acknowledge to be the caution of exploratory drillers?

A I'm sorry. I --

Q Well, let me begin by saying that on page 37 of your prepared evidence, I understood you to say that there is to some degree at

least, evidence of caution used in exploratory drilling.

A Yes, I was impressed by what I heard was happening. It seemed to me that it was done with care.

Q Yes, and that that caution provides counterweight, to some degree at least, to risks presented by high geo-pressures.

A I think that is the case, yes.

Q And what must be done is to take into account in planning and in estimating risk this factor of high geo-pressure?

A Yes, but it still results in increased risk.

Q Yes, I appreciate that, sir. Those are all the questions I have, Mr. Commissioner, of Dr. Pimlott.

THE COMMISSIONER: Any re-examination?

MR. BAYLY: No re-examination, Mr. Commissioner. I see it is 25 past 12 and I would suggest that we not start not Dr. Martell's evidence until 2:00.

THE COMMISSIONER: Right, well, thank you very much, Dr. Pimlott. We certainly have gained from your discussion of these problems and I mean the matters of environmental impact that you have dealt with. I make no comment on the reflections that you offered on the decision-making process that the government has followed in connection with the

proposed offshore drilling. I wonder if you would let Mr. Goudge and Dr. Fyles just look at the material that you have in front of you, and perhaps any documents that they wished copies of or wished to be introduced as exhibits might be -- arrangements might be made for them to be photocopied by the Inquiry so --

WITNESS PIMLOTT: If I might say, sir, in addition to this book, I have other documents and there are some of these that are, as far as I am concerned, I would be quite willing to make available to the Commission. I have no immediate -- I have finished the immediate job and in the whole question of risk, there is a supplementary volume entirely dealing with that and so I would be glad in any of these documents to have them deposited with the Commission.

THE COMMISSIONER: Thank you, Dr. Pimlott. Well, we'll adjourn till 2:00.

(WITNESS ASIDE)

(PROCEEDINGS ADJOURNED TILL 2:00 P.M.)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

ARTHUR M. MARTELL, sworn:

MR. GOUDGE: Perhaps, sir, before we begin the evidence of the next witness, could I tender as exhibits three documents which Dr. Pimlott has been good enough to leave with us and on which he relied. The first is a document entitled "Energy Under the Oceans, A Technological Assessment of Outer Continental Shelf, Oil and Gas Operation "

("ENERGY UNDER THE OCEANS", KASS, WHITE AND OTHERS, MARKED AS EXHIBIT NO. 442)

MR. GOUDGE: The second is a document entitled "O.C.S. Oil & Gas - An Environmental Assessment", which was a report to the President by the Council on Environmental Quality in the United States, dated April, 1974, and that's volume 1.

("O.C.S. OIL & GAS - AN ENVIRONMENTAL ASSESSMENT", VOLUME 1, APRIL, 1974, MARKED AS EXHIBIT NO. 443)

MR. GOUDGE: And the third document is entitled "Arctic Well Control Contingency Plan - Edmonton Alberta", dated January 1, 1973.

("ARCTIC WELL CONTROL CONTINGENCY PLAN", JANUARY 1, 1973, MARKED AS EXHIBIT NO. 444)

MR. GOUDGE: If I could tender those three documents, please.

THE COMMISSIONER: Right.

MR. BAYLY: Mr. Commissioner, just before beginning Dr. Martell's evidence, I've distributed the evidence of Dr. Allen Millen, to the participants here, and it will be mailed out to the other participants at some point today or tomorrow.

CROSS-EXAMINATION BY MR. BAYLY:

Q: Dr. Martell, I understand you've been sworn, and I wonder if you could turn to your curriculum vita attached to your evidence, and go through it for the Commission, please.

WITNESS MARTELL: I received my Bachelor of Science degree in biology at Acadia University in Nova Scotia, in 1967, and I continued at the same university to do a study on wintering water-

fowl, in a sanctuary area in Nova Scotia where I was to assess a management plan in relation to both hunting effects in the area and the effects of various environmental conditions.

I then went to the University of Alberta and did my doctoral work here in Mackenzie delta area, on tundra and forest populations of northern redbacked voles.

My professional experience dates just from 1966 when I did some work on the American dog tick in Nova Scotia, then did a summer's work on Atlantic mackerel with Fisheries' Research Board, my waterfowl work in relation to thesis work.

I did one summer's research and subsequently some later winter research and lab research leading to papers, on collared lemming on Devon Island. It's part of the International Biological Program, Tundra Biome.

While I was doing my doctoral research here, I also did some research on the effects of oil exploration activities on tundra small mammals, and tundra plant communties, on the upland shrub areas east of the Mackenzie delta, and this was done for Imperial Oil.

Following that, I worked for a year as a research associate of the Boreal Institute for Northern Studies, the University of Alberta. While working in that, as well as being involved in teaching a short course for A.R.M.O. program with Indian Affairs and being involved in a renewable resource mapping

project, the main part of my work there was involved in doing a literature review primarily, on the wildlife in the delta area, and this was to be written up in a form that would be usable by non-science people, but still try to incorporate enough of the references and hard data that it could be used as a scientific reference as well. This is the document to which I refer, this is about to go to Indian Affairs, it should have been there six months ago, but due to certain contingencies out of my control since I left there last June, it's just - I finished it off this fall at the request of the acting director, and it will be going to Indian Affairs, and I suppose if the Inquiry after I present my evidence were interested in it, it can be obtained through Barry Yates, at Indian Affairs in Ottawa.

Presently I am working as a research scientist for the Canadian Wildlife Service, Sault Ste. Marie, working on small mammals in relation to forest regeneration in Ontario. And attached are a list of publications that I have been involved in.

MR. BAYLY: Dr. Martell, I understand that we've shuffled your bibliography incorrectly, -

A Yes, I found when it got here, while it was being copied here, I guess, it has been shuffled around, so if you'd refer to the printed material, and take pages 27 to 31, and place those in front or following page 20, it then puts it back into the proper order. In other words, the page that says

"reports referred to or relyed on", and it makes reference to this report on the wildlife in the MacKenzie delta region, the following sets of literature cited then, are taken directly from the material, from the report, and refer to sections on fish, birds and mammals, respectively.

Q I wonder if we could turn then, Dr. Martell, to the first page of your evidence, and if you could begin by giving your evidence to the Inquiry, if you could begin by giving this evidence to the Inquiry?

A Right. I've titled the evidence "The Mackenzie Delta Wildlife - An Historical Review Of Man's Impact".

When we speak of the "Mackenzie Delta Area" in terms of people and wildlife we cannot consider only the modern delta of the Mackenzie River. Before the arrival of the Europeans the modern delta itself was little used relative to the surrounding areas, and, even with increased centralization of settlement, the people of the area ranged widely in their routine travels. This larger area may reasonably be considered to extend from the modern Mackenzie Delta west to Herschel Island and Lapierre House, south to the Fishing Lakes and LIttle Chicago, and east to Cape Bathurst and the forks of the Anderson River, and it's to this larger area that I will refer to as the Delta Area.

People probably first moved into the Delta area shortly after the end of the Wisconsin Glaciation,

or at least 10,000 years ago. These people used the wildlife resources of the region as the basis of their livelihood , and continued to do so unimpeded for the next few thousand years. The entrance of Europeans into the region in 1789 (Alexander Mackenzie's expedition), was also prompted by the wildlife of the region, but in this case money making wildlife - fur.

Although there was some fur trade in the Delta area through old Fort Good Hope between 1823 and 1826, and Old Fort Good Hope was located quite near Little Chicago at the bend in the Mackenzie River, fur trade in the region really developed only after the establishment of Peel's River Post (Fort McPherson) in 1840, Lapierre HOuse in 1845, and Fort Anderson in 1861. Fur remained the main economic base of the Delta economy until bowhead whaling replaced it betwen 1889 and 1910. During this period the Delta area was the Centre of the whaling industry in the the eastern Beaufort Sea and served as the winter port for a good portion of the Arctic whaling fleet; the Arctic Whaling Fleet is commonly referred to as such, and refers to the fleet sailing from San Francisco,the American whaling fleet. 74 ships wintered at Herschel Island and at least 24 ships wintered between Toker Point and Langton Bay. After 1910 there was an expansion and intensification of the fur trade, particularly noticeable in the 1920's. This boom eventually tapered off, however, and during the last 10 to 15 years, industry based on oil and gas exploration has become the main base of the Delta economy. It is probable that industry based on oil and

gas exploration and the development of reserves will continue to be the base for the next few decades.

Recently much concern has been expressed by Delta residents and other environmentally conscious groups over the impact of petroleum exploration and development activities on the wildlife of the region. This concern is not surprising when one considers that the wildlife resources have been the mainstay of the Delta economy for all but about 10 of the last 10,000 years.

Recordedinformation on the wildlife of the Delta area began with the explorer, Alexander Mackenzie, in 1789. Casual observations were made by the second Franklin expedition,by Franklin and Richardson, in 1825 and 1826, and by the Franklin Search Expeditions, (Armstrong, Hooper, McCLure, Miertsching, Nelson, Pullen, and Richardson), between 1848 and 1853. The most notable of these explorers was John Richardson who made a few biological collections in the Delta Area in 1826 and 1848.

The early fur traders, Isbister, MacFarlane, and Ross, made somewhat more detailed observations on the wildlife of the region, as it was the basis of their livelihood. The most noticeable of these was Roderick MacFarlane, who explored the Anderson River in 1857 and 1859 and established and operated Fort Anderson between 1861 and 1864. During this relatively short period, MacFarlane collected thousands of specimens of birds and mammals in the Anderson River and Bathurst Peninsula area. These collections formed the basis

of our knowledge of the wildlife of the region for the next fifty to seventy-five years, and in fact, some of MacFarlane's collections are still the only collections in certain parts of the Delta region.

The missionaries began activities in the Delta Area about 1860, but the only missionary notable for his observations on wildlife was Father Emile Petitot who was active in the region between 1865 and 1872. The whalers were active in the Delta area between 1889 and 1910, but were generally more interested in bowhead whales than in other wildlife. However, a few of them, Bodfish, Cook, Klengenberg, and Pedersen, made general observations.

A number of explorers visited the Delta Area between 1889 and 1907: Harrison, Preble, Russell, Sainville, Seale, Stefansson and Stone, and most of them made observations on the wildlife of the region; in fact, several of these expeditions were specifically designed for collection of information on wildlife. Between 1908 and 1918, two significant expeditions visited the Delta area: the Stefansson-Anderson expedition of 1908 to 1912, and the Canadian Arctic Expedition of 1913 to 1918. Largely through the work of Rudolph Anderson, these expeditions gathered much basic information on the birds, mammals and fish of the region. Anderson's work formed the best basis of information on the wildlife of the Delta Area since that of MacFarlane, and this information was largely non-overlapping as they concentrated their work in different parts of the

region. Two other expeditions passed through the Delta Area in the early part of this century and made casual observations on wildlife: the Gjoa Expedition of 1903 to 1907, and the Fifth Thule Expedition of 1921 to 1924.

Between 1927 and 1935, Alfred Porsild worked in the Delta ARea, particularly near the modern Mackenzie Delta. And again, primarily in areas non-overlapping with those areas worked by Anderson and MacFarlane. He gathered the best information on the wildlife of the region from its discovery in 1789 until after the Second World War. But this information, gathered by MacFarlane, Anderson and Porsild, along with the many casual observations of other visitors to the Delta Area, is the sum of our documented knowledge of the wildlife of the region for the first 150 years after its discovery. For the most part, however, this information consists merely of lists of the animals found in the region, and some natural history observations. Little was known either of the detailed ecology of the Delta ARea or of any of the animal species found there. There is, therefore, no real way of evaluating the impact of man's activities during that period.

There were two major sources of disturbance to the wildlife of the Delta region prior to about 1960: the fur trade and the whaling industry. Both of these, especially the whaling industry, were intensive programs designed to extract resources from the region with minimal cost and maximum profit. Little or no thought was given to long-term planned harvesting

of these renewable resources until relatively recently, when controlled fur harvests were begun.

Hundreds of thousands of muskrat, beaver, marten, mink, wolverine, lynx, fox, and other fur bearers have been harvested in the Delta area since the establishment of the fur trade. That populations of these species still exist, despite the trapping pressure, cannot be taken as evidence that trapping has had no impact on them. However, it is virtually impossible to determine what the impact has been as no data is available on the populations prior to trapping and few studies have been done since.

One exception to this general case is the beaver. According to Knud Lang, 1867 was the last year beavers were taken in large numbers in the Mackenzie Delta area, - I should mention Knud Land was a fur trader that worked in the Delta Area for many years and had quite a bit of practical experience in terms of the fur trade - but they were still fairly numerous 1900 to 1910. Populations then declined and the beaver was scarce by about 1925 and remained so until the Beaver Sanctuary was established in 1940. With protection, beaver apparently increased or did increase apparently with protection I should say, sorry, and by 1947 there was a small scattered population on either side of the modern Mackenzie Delta. The increase was particularly noticeable after 1949, and with minor fluctuation, remained high until 1965.

This general pattern suggests that the decline in beaver populations was the direct

result of overtrapping. However, other historical information does not confirm this pattern. Mackenzie inquired about various animals when he met a group of Indians near the outlet of Travaillant Lake in 1789 but reported:

"As for the beaver, the existence of such a creature does not seem to be known by them."

Beaver were not mentioned by several other early travellers on the lower Mackenzie River and the modern Mackenzie Delta: Franklin, Hooper, Isbister, Pullen, and Richardson, but Richardson did report the beaver inhabited the shores of the Mackenzie River to 67 1/2° or 68° North, and MacFarlane reported beaver on the Carnwath River in the vicinity of Fort Anderson. This suggests that beaver may never have been very abundant in the Delta area. The historical data base therefore is inadequate to explain beaver population fluctuations in the region.

Beaver in the Delta area, however, have been studied by Canadian Wildlife Service personnel, principally Vern Hawley. These studies documented a sharp decline in the beaver population between 1965 and 1970, and found that the decline was associated with a degradation of food supplies rather than overtrapping. This suggests then, that past fluctuations in beaver numbers may also have been more related to food supplies than to trapping pressure, although, on the other hand, trapping cannot be entirely ruled out. It leaves us then at an impasse, in deciding the cause of beaver fluctuations.

The whaling industry produced a more clear-cut impact on the wildlife of the Delta Area, and not only to bowhead whales. The whalers utilized large numbers of caribou, Dall sheep, moose, muskox, rabbits, ptarmigan, and waterfowl for food. Only their impact on bowhead, caribou, and muskox has been noticeable.

Between 1889 and 1910 a total of at least 98 ships wintered in the Delta region: 74 at Herschel Island, at least 14 at Cape Bathurst and Baillie Island, 9 at Langton Bay, and 1 at Toker Point. Each of these ships had about a 50-man crew, about ten to twelve Inuit hunters, and twenty to fifty dogs. These ships relied heavily on the wildlife of the Delta Area for winter meat supplies. Based on whalers' accounts and other available information, each ship used an average of about 13,500 pounds of game meat per winter, primarily caribou.

THE COMMISSIONER: When you say, Dr. Martell, that a total of 98 ships wintered in the Delta between 1889 and 1910, you mean over that period of time, altogether?

A This is a accumulative number , yes.

Because of the distance this game was hunted from the ships, normally only the saddle of the caribou, or the area toward the lower back and hindquarters where the meat's concentrated, was brought in; these weighed an average of 31.5 pounds. Therefore we can estimate, between 1890 and 1908, whalers wintering

at Herschel Island harvested at least 32,000 caribou, an average of 1,800 per year, primarily from the Porcupine Herd, and between 1897 and 1910, whalers wintering east of the modern Mackenzie Delta harvested at least 10,000 caribou, primarily from the Bluenose Herd.

Because of the lack of baseline data, it is virtually impossible to estimate the magnitude of the impact of these harvests on the caribou herds. It is likely, however, based on present dat information on the Porcupine Caribou Herd, that the harvest had negligible effect on the herd as a whole. However, Knud Lang observed that after the whalers, people had to travel far inland to hunt caribou, and not until 1926 did caribou reappear in the foothills west of the modern Mackenzie Delta. It is possible then that the whalers' harvest affected the portion of the herd which normally winters in the northern parts of the wintering range, but this is only conjecture in the absence of good baseline data.

It is more likely that the whalers affected the portion of the Bluenose Herd using the Delta area. Early explorers between 1827 and 1853, reported caribou on the Caribou Hills; on Ellice, Kendall, and Richards Islands; and along the Arcitc coast of the Tuktoyaktuk Peninsula. Caribou were still reported as common in these areas in the 1890's, but were observed to be declining rapidly by the early 1900's. This population was never very large and the harvest of at least 10,000 animals in only

thirteen years must have reduced the stock considerably and may thereby have altered traditional migration patterns. Porsild noted,

"In many places on the Caribou Hills and in the Eskimo Lake basin deep-worn trails were still clearly visible in 1927 and 1928, and testified to the former presence of numerous caribou."

The Bluenose Herd presently uses only a portion of its former range in the Delta area. Until about ten years ago, its range was essentially restricted to areas east of the Anderson River, but since that time it has been expanding westward at least to the Kugaluk and perhaps to Travaillant Lake area. Again, in the absence of firm baseline data, an estimation of the impact must remain conjectural.

The whalers also hunted muskoxen for winter food supplies. Information on either the original status of muskox in the Delta area, or the actual harvest by whalers is very scant. MacFarlane reported that in the 1850's, muskoxen were uncommon between the Mackenzie and Anderson Rivers, but were common east of the Anderson River. Originally, muskoxen were probably little hunted by the inhabitants of the Delta area, but, after the establishment of Hudson Bay Company posts, many hides were brought in for trade. Anderson reported that by 1890, muskoxen had been extirpated west of the Anderson River. The actual arrival of the whalers brought new pressures to bear on the remaining stocks. Bodfish, a whaling captain, who wintered at Langton Bay 1897 and 1898,

and Baillie Island 1898 and 1899, and 1900 and 1901, noted that,

"While we wintered in the Arctic, they," referring to the Inuit's hunting for the whaling ships, "killed all the muskoxen in an area of 150 miles."

By the early 1900's, muskoxen were extirpated from the Delta region and the western boundary of their distribution was far east of the Anderson River. It is quite likely that man's activities were largely reponsible for the loss of muskox from the fauna of the Delta region.

The impact of the whalers on the bowhead whale stock is the most conspicuous case of man's disturbance to Delta wildlife. Traditionally, the Nuvorugmiut living on the Tuktoyaktuk Peninsula, and the Avvagmiut on Bathurst Peninsula hunted bowhead, probably taking small, immature, animals. Richardson encountered bowhead hunters at Cape Bathurst in 1848 and reported,

"In some summers they kill two black whales, very rarely three, and sometimes they are altogether unsuccessful."

McClure reported that hunters at Warren Point in 1850 had taken three towhead that season, and MacFarlane noted that the Anderson River Inuit in the 1860's succeeded most seasons in killing one bowhead, but seldom as many as two. Petitot met an old hunter in 1868 who had killed only seven bowheads in over 50 years as a hunter. Clearly the hunting pressure on the eastern Beaufort Sea bowhead population by Inuit

was minimal. The impact of the American whalers is in sharp contrast to this.

The whalers operated in the Delta area mainly between 1889, when the first ships reached Herschel Island, until about 1906 when the price of whalebone dropped drastically and made Arctic whaling unprofitable. Relatively few whales were taken between 1889 and 1892 or after 1900; the peak of the hunting occurred in the intervening seven years, 1893 to 1899. In 1908, Inspector Jarvis of the North-west Mounted Police, Herschel Island Detachment, estimated that 1,345 bowheads were killed in Canadian waters between 1889 and 1907, and this appears to be a reasonable estimate. At least another 100 bowheads were taken in the Delta area between 1908 and 1915. Therefore, in only 27 years, and primarily in only seven years, almost 1,500 bowheads were taken in the eastern Beaufort Sea. Today only about 100 bowheads summer in the eastern Beaufort Sea. This tremendous reduction in the bowhead whale stock is almost certainly entirely due to the whalers.

We have, then, several cases of possible disturbance to Delta Area wildlife as a result of man's activities. Only in the case of the bowhead whale is man clearly the culprit, although he is highly suspect in the cases of caribou east of the modern Mackenzie Delta and muskoxen. How detectable would these disturbances have been at the time they were occurring? I suggest that in several of the cases we would not have known the magnitude of the disturbance

until it was very great due to the lack of solid baseline data. The question I would now like to raise is whether we are really any better off today in being able to assess disturbance to wildlife populations in the Mackenzie Delta Area.

After the Second World War more detailed studies began on the wildlife of the Delta Area, particularly on the economic species such as beaver, muskrat, and waterfowl. During the last ten years, probably more manpower has been expended in the study of wildlife of the Delta region than has been during the previous 175 years. How good is our present data base? I would like to discuss the available, and I mean published or available unpublished information, for each of the major groups of wildlife - fish, birds, mammals - as well as for some selected species. When I speak of what we know, I am referring only to this published or available information.

The Mackenzie Delta Area can be divided into four general drainages: the Yukon River Basin, which includes the Porcupine and Bell Rivers; the Yukon North Slope which includes the Firth, Babbage, and Blow Rivers; the Mackenzie River Basin, which includes the Peel River and the modern Mackenzie Delta; and the Eastern Coastal Drainage, east of the Modern Mackenzie Delta, which includes the Miner, Kugaluk, Anderson, and Horton Rivers. The majority of the information available on fish in the Delta region is from the first three of these drainages; virtually nothing is known of the Eastern Coastal

Drainage.

The general distributions of the 61 species of fish reported from the Delta Area have been reasonably well documented for freshwater species in the modern Mackenzie Delta and west. However, little is known of their distributions east of the modern Delta, and even less is known of their distribution in coastal waters.

A total of only about fifty known spawning sites and forty known nursery sites have been located in the region, primarily since 1971. When these locations are mapped it can be seen that they appear to occur in discrete areas, rather than being scattered throughout the entire region. Further, these descrete areas lie principally along the proposed pipeline corridors. Therefore the distribution of known spawning and nursery sites within the Delta region merely reflects where they have been looked for intensively, and it cannot be assumed, either that the most important have been found or that a stream crossing the pipeline route will not have an important site on it, outside of the corridor. Also, only about one-third of the species have recorded spawning sites, and only about one-quarter have recorded nursery areas.

Although some species of fish in the Delta region are relatively sedentary, others follow seasonal migrations which may be either fairly local or over long distances. There is relatively little information available on these movements, although we know that lake whitefish, broad whitefish, and

inconnu, some are in coastal waters and make long upstream migrations in the fall, perhaps as far as Fort Good Hope. Seasonal spawning migrations have been recorded for a few species of fish in parts of the region. Seasonal movements have been documented only at a few sites in the Delta Area. In this I mean continuous records of the proportions of catch at specific sites: Aklavik, Arctic Red River, Rat River, and then only for one or two years. No information is available on longterm fluctuations in the timing or magnitude of seasonal movements or spawning runs.

Of the major fish species in the Delta ARea, good biological data are available only for the Arctic char ; the biology of most of the other species is generally poorly known. Burbot, or loche, and lake char - lake trout - are conspicuous by the lack of information, even on their reproductive patterns and movements, despite the importance of these two species to Delta area residents.

Because of the lack of good longterm, quantitative data on even the major fish species in the Delta area, it is unlikely either that any slight disturbance to their populations could be detected, or that the exact cause of any major disturbance could be assigned.

The general distribution of the 118 species of birds reported breeding in the Delta area is reasonably well known; however, the region east of the modern Mackenzie Delta is generally poorly known compared with the modern Delta and the area to

the west. This is primarily due to recent research associated with the proposed pipeline corridors. Breeding bird surveys have been done in several areas along these proposed corridors since 1971, but only in a very few sites - only a very few sites have been sampled for more than one year. Therefore, no information is available on potential annual fluctuation, in either the composition or density of breeding bird populations. Without such data it is impossible to determine whether any changes detected in these communities at a future date are due to man-induced disturbance or to normal - we can class something as being normal - variations caused either by annual differences in weather patterns, or fluctuations in some of the species themselves.

Probably the two most important groups of birds in the Delta area, to Delta area residents, are ptarmigan and waterfowl. Very little is known of the biology of any of the three species of ptarmigan, or any of the 16 species of ducks breeding in the region, but the situation is better for the whistling swan and the four species of geese.

An aerial census of waterfowl has been made in the Delta area each spring since 1948. This is by the U.S. Fish & Wildlife Service, originally. These surveys show the great variation in both the composition and density of waterfowl between years due to natural variations in weather patterns. The greatest duck densities and the highest proportion of dabbling ducks, primarily Pintail, Wigeon, and

Mallard, was found around 1960, which coincides with a period of drought on the prairies. In dry years, waterfowl which normally nest in prairie ponds move further north where conditions are always wet.

Without such a continuous record of waterfowl populations, changes in numbers, either could not be assigned to a cause or could be misconstrued. Porsild reported that nesting Canada Geese in the southern part of the modern Mackenzie Delta decreased markedly in the period 1915 to 1935, and attributed this decrease to the increase in human activities in the region. Because of the lack of a data base, Porsild could not either truly document the decrease, or assign its cause with any accuracy. Cowan, a biologist who visited the modern Mackenzie Delta in 1947, compared his waterfowl observations with those of Porsild who was there in 1934. Cowan reported a total decline in waterfowl populations of 91 to 97%, with the decline in Wigeon and Pintail approaching 99%. Cowan expressed great concern over this disastrous decline. However, the apparent decline was probably due to the great numbers of prairie waterfowl present in the Delta area during the dry years of the 1930's, as compared to more normal densities when Cowan made his observations in 1947. Because he did not have a good data base, Cowan could not reach this conclusion.

These cases, I feel, emphasize the need for a longterm data base for the assessment of the effects of potential disturbance. The base must be sensitive, however. The aerial surveys of waterfowl

run since 1948 give us a base to detect changes of relatively large magnitude, but the technique is relatively insensitive and would not enable small scale disturbances to be detected.

Largely through the efforts of Dr. Tom Barry of the Canadian Wildlife Service, who has worked in the Delta area for over fifteen years, we have good information on the biology of Whistling swan and geese: Brant, snowgeese, white-fronted geese, and Canada geese; in the Delta area. This information is essential because the greated density of whistling swans in Canada is found along the coastal strip from the west side of the modern Mackenzie Delta to the east side of the Anderson River Delta, and because over 15,000 snow geese, 3,00 Brant, and 6,000 white-fronted geese breed in the Delta area. Barry has also collected vital information on the location of critical areas within the Delta region for migrating, nesting and moulting of waterfowl.

Two major waterfowl migration pathways in northwestern North America pass through the Delta area; the coastal route around Alaska used by Brant, Oldsquaw, and eiders; and the Mackenzie River Valley, used by the remaining waterfowl species. Because of these major migration routes, most of the waterfowl which breed in the western Arctic pass through the Delta area in spring and fall. Barry reported that in late May and early June 1972, almost 200,000 geese, over 1,100,000 Oldsquaw, and almost 1,240,000 eiders passed Cape Dalhousie on migration.

THE COMMISIONER: Excuse me, where is Cape Dalhousie?

A Right at the tip of the Tuk Peninsula.

The need for a detailed base line data is clear.

Barry's stud.y on the reproductive biology of geese in the Delta area have shown the sensitivity of geese to disturbance during the breeding season. Because of the short Arctic summer, the schedule of goose nesting activities is very tight. Once nesting can begin, there is only about a ten day period during which all other nests are initiated. Incubation begins after the last egg of the clutch is layed and lasts 22 to 24 days, depending on the species. Young geese grow rapidly and this rapid growth is necessary if the young birds are to be able to migrate south with their parents at the end of the summer. Because of this tight schedule, birds which are delayed in nesting due to adverse weather conditions, may not nest at all, and birds which lose their clutches through weather or predation cannot re-nest successfully.

Adverse weather conditions may affect waterfowl both directly and indirectly. Barry estimated that 100,000 eiders died of starvation in the eatern Beaufort Sea in the the spring of 1964. He attributed this mortality to the severity of the weather; low temperatures allowed pack ice to be present most of the summer and many leads to be frozen

over until mid-July. The adverse weather in 1964 also resulted in the loss in the Anderson River delta of 100% of the snow goose nests, 75% of the white-fronted goose nests, and 50% of the Brant nests. Adverse weather conditions resulted in virtually no goose nesting success in the Delta region again in 1974. Fortunately, years as severe as 1964 and 1974 are uncommon but they do illustrate the great influence of environmental conditions on northern-breeding waterfowl. These cases also illustrate the need for a good longterm data base in order to begin to understand how disturbances by man might affect waterfowl populations. Waterfowl populations are probably much more sensitive to disturbance both in years of adverse weather conditions because of the generally poor physiological condition of the birds, and in subsequent years, when their losses are being made up, than in a good year after a series of good years.

The distribution of most of the 42 species of mammals resident in the Delta area is probably better known than those of fish and birds. However, we have good information on the biology of only a few of these species. The aquatic furbearers, beaver and muskrat, have received the greatest amount of attention, primarily through the work of Vern Hawley and Ward Stevens of the Canadian Wildlife Service. Beaver and muskart habitat has been surveyed and classified as to its potential for fur production, and detailed studies have been done on both species in the modern Mackenzie Delta. From this work we know that

populations of both species fluctuated greatly over the years but they do not fluctuate together. In the last fifteen years beaver populations were highest between 1962 and 1965, and then declined, as mentioned previously, probably due to a degradation of food supplies, while muskrats were very high in 1962 and again in 1968, and were markedly lower in the other years. The cause of these fluctuations is not known and their predictability is not possible.

The detailed studied on beaver and muskrat have outlined the sequence of events in the animals' annual cycles and therefore provides some insight into the periods of the year when the animals might be the most vulnerable to disturbance.

Extremely little is known of the biology of the remaining fur bearers of the region, despite their economic importance. Arctic fox habitat has been mapped and some surveys of denning density were run on the Yukon North Slope during one year. Den site requirements of Arctic fox and red fox on Richards Island have been examined briefly. Except for the small amount of information, virtually nothing is known of the biology of either Arctic fox or red fox in the Delta area. Some studies have been made on marten and mink but generally little is known. Virtually nothing is known of the biology of wolf, wolverine, and lynx in the Delta area.

As I pointed out earlier, when I say "nothing is known" I am referring to published information. It is impossible for a man to be a

successful trapper and not know a great deal about the habits of the animals he is trapping, and there are many successful trappers in the Mackenzie Delta area. The trapper must be aware of the habitat types used by the animals for hunting and for shelter, and their times of activity and movement. The trapper is also very aware of the sensitivity of the animals to foreign odours, which may be found in traps and trapping equipment, and to the alteration to snow cover and vegetation caused by trapping activities. This knowledge is gained through many years of experience. The trapper is sensitive to changes in animal numbers and behaviour in the local areas he is familiar with. Because he does not have sufficiently detailed information on the animals' year long activities over a large area, he cannot always make accurate interpretations of his observations. And if I could digress a minute, here, this is fairly clear because of the relatively rigid schedule of yearly activities that a trapper is tied to. In areas, for instance, where he might be hunting Arctic fox or trapping Arctic fox on the coast in the winter, at the time the same foxes are denning, he's probably in an entirely different area, and possibly occupied with other activities. He then has no information on what conditions are present at the time the Arctic foxes are actually denning, or on the time the pups are being weaned.

(QUALIFICATIONS & EVIDENCE OF A.M. MARTELL MARKED EXHIBIT 445)

A: So this is why he cannot always make accurate interpretations of the observations. And I'd suggest that with the general level of the data base, available to biologists for the delta area, we are not necessarily much better off.

The large mammals such as caribou, moose and Dall sheep are important in the delta region as sources of food. It has only been within the last five years, any good data have been available on the great caribou herd west of the modern Mackenzie Delta. As much testimony has already been presented on the porcupine herd, I will not rediscuss it.

Barren ground caribou are also found in the delta region, east of the Kugaluk River, and this is part of the bluenose herd. Little is known of these animals in the delta area, but studies are presently being carried out on them by Vern Holly of the Canadian Wildlife Service.

European reindeer occupy much of the former barren ground caribou range between the modern Mackenzie Delta and the Kugaluk River. These animals are presently being managed and consequently the effects of man-made disturbances my be more easily detected in these animals, than in the other caribou herds in the delta region.

A group of probable caribou - reindeer hybrids occupies the range between the Eskimo Lakes and the Mackenzie River, centered on the Kugaluk River. This herd of about 1,000 or 2,000 animals has only been tentatively identified, and

virtually nothing is known of them.

Moose and Dall sheep habitat has been mapped in the delta area, and the most important areas for these species have been identified. Except for this documentation of distribution, virtually nothing is known of the biology of moose or Dall sheep in the region.

Until very recently, little was known of the biology of bowhead or beluga, in the delta area. Information gathered within the last ten years, and particularly within the last five years, has greatly increased our knowledge of whale numbers and movements in the eastern Beaufort Sea, and of variations between years. However, the variation in this information gathered, underlines the need for continuing studies of a good data basis to be established. Little information is yet available on the basic biology of whales in the delta region.

Grizzly bear, polar bear and seals are also of importance to the people of the delta area. These animals have been receiving attention within the last few years. Surveys are being run by the Canadian Wildlife Service to determine the distribution of polar bears and ring seal and bearded seal along the coast of the delta area. More intensive work is presently being done in the eastern Beaufort Sea and Amundson Gulf. This data will have some application to populations in the delta region.

Grizzly bear habitat has been surveyed in the delta area, and some basic information

on their biology has been collected. Presently more intensive studies of grizzly bear are being carried out by the Canadian Wildlife Service and these should produce a better data base, for the evaluation of man-induced disturbance to the grizzly populations.

Within the last fifteen years, there have been many cases of disturbance to wildlife in the delta area. These have been due both to physical alterations to wildlife habitat, such as gravel pits, seismic lines, drilling sites, winter roads, and artificial islands, and to the increased presence of man and his machines; this latter case exemplified both by the density of staging sites, seismic camps, drilling rigs, and by the large amount of overland travel by nodwells, and trucks in winter, boats in summer, and airplanes and helicopters year-round.

Residents of the delta area have reported that fish in the Eskimo Lakes and Crossley Lakes, and muskrats and snowshoe hare in the modern Mackenzie Delta have been affected by these disturbances. However, very little research has been done, either to determine the effects of these disturbances, or to confirm or deny the observations of delta residents.

I have reviewed the historical evidence of disturbance to the wildlife of the delta area by resource extraction industries in the past. We can be sure that present resource extraction based industries in this delta area are also causing disturbance to delta wildlife. However, we do not know the magnitude of this disturbance.

Because of the historical, present and future importance of wildlife to residents of the delta area, it is essential that the resource be maintained. This can be accomplished only through careful management of the resource, to ensure firstly that the status of any component of the delta fauna is not seriously altered, and secondly that the resource be available for continuing use by delta residents.

Throughout this presentation, I have emphasized the necessity for a solid long-term data base in order to detect and assess the effects of man-induced disturbances to wildlife populations. I do not feel that this can be over-emphasized. The onus of proof should not be on the party who suggests that disturbance has occurred, for without such a data base he will not be able to demonstrate cause, except in the most obvious cases, which are often only ones of very great disturbance.

The onus of proof should rather rest on the party wishing to cause a predervation(?) to demonstrate that wildlife populations will not be affected, and I believe that this is only possible with a solid long-term data base.

MR. BAYLY: Mr. Commissioner, that completes the direct evidence of Dr. Martell, and he is available for cross-examination at this time.

MR. GOUDGE: May I suggest that we break for coffee, sir?

THE COMMISSIONER: Fine

(PROCEEDINGS ADJOURNED FOR A FEW MINUTES)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: Well, Mr. Carter, any question?

MR. CARTER: I don't have any questions.

THE COMMISSIONER: Mr. Lutes?

MR. LUTES: No thank you, Mr. Commissioner.

THE COMMISSIONER: Mr. Goudge?

MR. GOUDGE: Yes sir.

CROSS-EXAMINATION BY MR. GOUDGE:

Q Dr. Martell, you conclude your evidence by speaking of onus of proof, and that follows your general proposition, as I understand you, that a longterm data base is absolutely essential. That's your basic proposition.

A Yes.

Q That data base is essential if one is to make any analysis of impact of any kind?

A I'd like to refer, if I could, to really intending it to be a little broader. Now, we may be able to get away with a slight amount of information, let's say we can detect a disturbance, but what can we do about it? I would maintain that this good data base, in other words one that would enable us to make good management recommendations, is necessary

in order to first of all detect, it certainly will do that; but it also will allow us a means of correction, or modification to practices, which may be causing a disturbance.

Q Could you give me an example of that second consequence the adequate data base?

A Let's take the case of water fowl. That's probably, I think, the best one, of geese nesting where it's been well enough and carefully enough documented that, if observations are made, let's say, in large losses of clutches in an area, during a year when there apparently is no harsh environmental conditions - there haven't been any storm tides, or something - maybe, let's say there has been heavy aircraft activity because it happens to be on a flight route, this small colony, hypothetical colony is on a flight route between a staging area and a rig site, as an example. One may not at first of all, without the base one may not have been able to detect what was might have been able to detect what was occurring, but wouldn't have known that this loss in clutch, 20 or 30 per cent, was unusual.

With the base we can say, yes it's unusual, and because we know the pattern is tight enough on the birds, and because we know the incubation time is important, we can start to look at it carefully, and perhaps we'll see that the aircraft flight route flight has been low enough to cause the birds to be leaving the nests at a frequency great enough that

they're losing the clutches, due to lack of proper incubation time. This can then be easily corrected by altering the flight route, cancelling the flights, raising the height or one thing or another.

Now, in the other sense, if we had no information on the birds, except that they're in the area, and we detect a slight loss, a bit of a loss in clutches, we first of all may not be sure that that's not normal. Even if we are, we may not be sure why.

Q Let alone what to do about it.

A Let alone what to do about it.

Q Yes, I understand that. In dealing with the onus of proof that you refer to then, you're not suggesting I take it, that the onus of proof is on the developer to do anything more than suggest the impact. You're not suggesting that the onus of developing the data base is the developer?

A No.

Q I take it you would see that to be a job for government?

A Yes.

Q I wonder if you've given any thought to dealing with the particular area of concern that we have, and perhaps more particularly the delta within the valley; whether given your views of the inadequate data base, what kind of general research program would be necessary to bring it up to

standard?

A I'm afraid I feel quite incompetent really to comment on that, and that I'm not really aware of the actual detail of the projects presently ongoing, that have not been published. I don't think it would be appropriate for me to make such comment without this information.

Q I see. There's no doubt that there are a number of ongoing studies which will add to the baseline data in the area.

A Yes. I feel that it is increasing, but I do feel that there's a need for a strong government involvement, particularly in relation to developing management programs, around the various species, and the system as a whole, in order to truly both assess, and do something about, or correct, moderate any potential disturbances.

Q Yes. But there's no doubt, I take it, in your mind that over the past five or ten years in particular, there's been a substantial addition to our baseline information, in the valley and the delta, and to give government and industry their due, they've participated in large measure in that.

A That's right. But I feel there still is -

Q Your view is there's still a long way to go.

A Still a long way to go, yes.

If I could make a comment on that, as well, I feel as a personal opinion, that there's a very great value to having, let's say, one researcher, or several researchers, working in an area, be it even if they're changing projects. If they're working on species A for a few years, and then switch over to species B, and maybe to C, there's an intangible value that's very hard to pinpoint, that's gained through the experience of this individual working in the area, and preferably living in the area, continuously over a long term.

He's able to make, I feel, very good judgements on things that he may not specifically have worked on, but he has been able to carry out observations on, over a long period, and I'd like to put this in contrast to a similar length study, done by a dozen different people, none of whom have spent more than one year in the same area; and I really feel there's a significant difference in what one can do in terms of management, with these two types of programs.

Q So at least one of the factors you would build into a program necessary to build the baseline data bank to an adequate state, would be just that; keep the same people around on a variety of subjects.

A Preferably residents of the area.

Q Do you have any views as to how long, in general terms, it would take to get

this baseline data to a position where you feel it would be adequate ?

A I'm inclined to comment similar to Dr. Pimlott's testimony this morning, where he said, well, we can have - there is a very long term, but this is not always realistic in terms of the planning that's necessary, so we should be looking at shorter term programs around them, and I think perhaps in some areas, I'm not familiar with all of the testimony that's been presented, but I'm certainly at least in some species, probably the testimony has come in, I would anticipate, would enable some of these decisions to be made with the data base gathered so far.

But I think it's important that we look a little broader than perhaps has been looked, in case there are specific links that we are missing within the system as a whole, rather than just concentrating on the glamour species.

Q Are you prepared to comment on Dr. Pimlott's sort of outside time frame of ten years for the development of this kind of data bank that's satisfactory?

A I would think that a great deal could be accomplished by a number of individuals working in the area over a ten year period continuously. I think within that time frame certainly they should be able to develop good management programs, for the most important species.

Q Well within that time frame?

A I would hope so, yes.

Q Five years?

A I think this is contingent upon the fact, within five years they should have developed to the point that given that they will be there the remaining five years, while some information is needed, then maybe yes. If they were to be replaced in five years with somebody else that just had their reports to refer to, perhaps not.

Q I take it you'd be reluctant to see anything satisfactory develop within a timeframe of much less than five years?

A Personally, I'd feel that five years would be a minimal time.

Q Now sir, in dealing with — on page 19 of your prepared evidence, certain of the disturbance factors that have occurred in the delta in the last fifteen years, you concentrate in large part on alterations to the physical habitat. I take it you acknowledge as well, the environmental impact of increased access due to, and hunting consequent on that for example, as a factor leading to impact.

A Yes, this would be something that -

Q If you had to compare those two general kinds of impact, alteration of habitat versus increased access and accompanying increase in hunting, which has been over the last ten or fifteen years, of more damage?

A I would presume it was the

physical, and those due to man's travel and activities; in other words the non-hunting forms of disturbance.

Data on beluga hunting, for instance, seems to indicate that there may not have been any substantial difference in the average yearly kill over perhaps the last twenty years.

Would you be prepared to qualify that comparison? Is the physical four times, five times as damaging?

A No. I'm afraid I can't. Really all I can say that I am, in terms of this testimony, is I'm a reviewer, I have reviewed a great deal of published information. I don't claim to be an authority on this whole broad area. Rather, I've reviewed the information, and due to the fact that there aren't any other reviews of a similar nature available, and I can comment only on what I've done.

Q I appreciate your concern, Dr. Martell, and I'm happy to have you say you'd rather not answer, if you don't feel qualified to answer.

Let me ask you two or three more questions. On page 6 of your prepared evidence, if I can ask you to turn to that sir, you say at the bottom that it is likely that, based on present day information on the Porcupine caribou herd, that the harvest had negligible effect on the herd as a whole.

Now dealing with that specific reference, how do you come to that conclusion, what was the information you used as a basis for that

conclusion?

A Okay, one minute here. It's based primarily on information gathered by Dr. George Calef, and published. In looking at the caribou herd reported in a 1974 publication, that the present annual harvest was unlikely to exceed 4,000 animals, or approximately 25% of the annual production; and he concluded that this harvest has a negligible effect on the herd.

Now, given the assumption that an annual harvest of 4,000 animals on the present herd size is negligible, then I concluded an average harvest of 1,800 animals would also have been negligible, but with the underlying assumption of course, that the Porcupine herd was not significantly smaller at that time of the whalers.

Q Obviously, if it was smaller, hunting would have had an impact.

A It could have, and on the herd a a whole, I try to emphasize there, and in comparing the 1,800 and 4,000 animals the herd would have/to have been half the size or less, in order to have - the herd as a whole.

Q And while you think that's unlikely, you simply have no data base available to allow you to say that?

A Exactly.

Q Now let me ask you to turn pages 14 and 15 of your prepared evidence, and as I understand the general thrust of your evidence, and

you tell me if I have it right, you say there in general terms that some periods in the annual life cycle of water fowl are very critical, and that adverse weather conditions can affect water fowl population at those times. Is that the general thrust of what you say in those pages?

A Yes.

Q Would you agree that man-induced disturbance in those times, even of a normally minor nature, might have a very large impact, particularly if it is imposed during those critical periods?

A Yes. It's quite likely that disturbance of any nature, to the regular routine of activities of the birds, would be damaging to their annual production.

Q And I take it from that, the conclusion is that during those times, there'd be the most stringent control of activities?

A Yes.

Q So that what we may see if, given the importance of time as an element, is controls which have to vary in stringency according to the time at which they apply.

A Exactly, and in the case of water fowl, it's one of the few cases we can pinpoint these are exact periods when it is most critical.

Q Would you assume though, that if base line data research were done for other species, that the same kinds of hyper-sensitive times might show up?

A Certainly for some of the species, and probably there are certain critical periods of the year for most of the species.

Q So as a dimension of the management problem, time has to be a vital element?

A Right. It has to be year round research involved.

Q But I'm speaking of what one does in imposing constraints on activity, perhaps I should call it the regulation problem. Time is a vital dimension to efficient regulation.

A Yes.

Q Now finally, Dr. Martell, as I understand you, you conclude from your research and evaluation of past disturbance, that it is certainly probable, perhaps very probable, that the anticipated increase in activity and human population, following these proposals that we're dealing with, would greatly increase the disturbance to wildlife. In general terms, do you have any doubt about that?

A I have no doubt.

Q I take it, the next step as far as you're concerned, is that that will prove detrimental, increased disturbance will prove detrimental to wildlife populations in many instances.

A That's the question. Disturbance is a very general term, and certainly we can't have any activity by man without creating some disturbance. The question is, is the disturbance, will the disturbance, the increased disturbance, affect the

populations significantly?

Q There's no doubt though, that, I take it, that some alteration in the intensity of management efforts will be required, if the problem is to be coped with.

A Yes.

Q As far as you're concerned, are the management agencies that exist at present to deal with management of wildlife in the valley and the delta, satisfactorily equipped to handle this increased problem, at present?

A I personally don't feel they are. I feel that increased funding must be made available, and staff perhaps as well, to the people who are attempting to manage the populations now, in order to cope with the increasing demands.

Q There's no doubt, I suggest to you, that both manpower and funds will have to be increased.

A That's my contention, yes.

MR. GOUDGE: I think, sir, those are all the questions I have of Dr. Martell.

MR. BAYLY: I have no re-examination, sir.

THE COMMISSIONER: Dr. Martell, you said that in a period of approximately seven years, at the turn of the century, 1,500 bowhead whales were taken. Do you have any notion at all of the size of the herd, that is the number of bowhead whales, that were to be found there before the whalers came?

A The only conclusion I can reach is that was probably a very good estimate also, of the population at that time.

Q I see.

A Now, this is the population using the eastern Beaufort Sea, not the entire bowhead stock, of which it's a part.

Q You mean - well, what is the entire bowhead stock, of which it's a part?

A It's what's referred to as Bering Chukchi stock, winters in the Bering Sea, moves north the largest part into the Chukchi Sea in summer, and one component swings to the east and into the eastern Beaufort Sea.

Q Also I was going to ask you, you kind of caught us at a bad time, being the last witness after three weeks of formal hearings - you were talking about the presence of the bluenose herds, that is that its range used to extend into the delta, and it has withdrawn, it appears now. I think this evidence came out at Yellowknife last month. It appears now to be moving into the delta again.

A Yes. The material I had available to me indicated that it had been increasing; it designated as I did in the testimony the possible presence of this group of intergrades, which I understand from recent conversations I've had, but not document published material, that this now may be engulfed by part of the bluenose herd, or may have been part of the herd, or the whole interfacing group of intergrades.

Q Yes. Now, just looking at the map of the delta, can you tell me where that is?

A The group of intergrades?

Q Would you mind just showing me?

A In general, the information I had available showed the Porcupine herd staying primarily to here, the barren ground caribou probably showing up right into the delta islands, here, and Ellis Island even, as well as right up the Tuk peninsula originally. Presently, from the information I had, it only came into this area, and this group of intergrades is probably in this area, wintering in this area, and in the summer to south of the lakes as opposed to the reindeer herd which at least in recent times, well within the last five to ten years anyway, has summered on the Tuk peninsula and then wintered either in this area, moving up to here to Taka, or most recently in the Prise Lake area.

THE COMMISSIONER: Right.

MR. BAYLY: Dr. Martell, could you identify those areas by name for the record, because all we will have is "this area" and "that area."

DR. MARTELL: The Porcupine herd I indicated the entire range west of the modern Mackenzie delta. The barrenground caribou, prior to 1900, in the outer islands of the modern Mackenzie delta, and everywhere from the Caribou Hills and down into Caribou Lake, Travaillant Lake and east, at least

at some seasons of the year; and presently, I indicated from the information I had, it was primarily west of the Kugaluk River, most likely based on some discussions I've had more recently, it has actually moved closer to Sitidge Lake and even into the Travaillant Lake area, and this group of possible intergrades probably summered in the Urquart Lake area, and wintered in the Travaillant Lake area. Then I indicated the modern reindeer herd, or the European reindeer herd in the area, within the last five years at least, is summering on the Tuk peninsula, wintering east, or excuse me, west and north of Sitidge Lake, moving into Old Man Lake to calve, and most recently wintering in the Parsons Lake area.

MR. GOUDGE: Dr. Martell, in terms of the bowheads, I'm correct, am I not, in understanding that while they're not extinct, there remain only about one hundred.

A This is the best available guess that I've seen published.

Q And they, as you say, winter in the east, but they do appear.

A Now this is the group in the eastern Beaufort Sea, yes.

Q And they do come over as far as Tuk, for instance, and beyond?

A Right, up past Cape Bathurst area, north of that area, perhaps into Franklin Bay.

Q Yes. And they're an

endangered species, as I understand it?

A I don't feel qualified to comment on that. I'm sure you'll be receiving testimony in the next few weeks from somebody who's able to.

MR. GOUDGE: Thanks, sir.

THE COMMISSIONER: When you were studying the extent of the data that exists, with relation to fish in the Mackenzie Delta, giving the delta its larger defintion that you have, did you examine the testimony that Mr. Steigenberger gave before the Inquiry in November or December?

A I finished my work on this project last June, so I've been unable to examine virtually any materials since last June.

Q You might - well, I leave this up to Mr. Bayly, really, but it may be the work of Steigenberger and Stein, and the other two people from the fisheries who gave evidence with them, it was already well known in one form or another in June when you put together your presentation, but it strikes me that perhaps not, because Mr. Steigenberger had done an enormous amount of work on the north coast of the Yukon, extending into what you call the delta.

Well at any rate, you might - I'm sure that those volumes of evidence are easily available to you - and you might just take a look at their evidence, and just send a note in through Mr. Bayly, if it alters your views in any way. I think that their views essentially appear to confirm your own, but you

might want to add something when you examine their testimony. And Dr. McCart as well. It kind of goes on, with the lawyers cross-examining them all, but, since you've reviewed the literature, your comments would be appreciated.

A I'm certain, and I was very concious of this all the time I was doing the study, that I was constantly rewriting sections; because I would have something written and suddenly a few more reports would come out.

Q I know, I know the feeling.

A So, it's a never-ending sort of battle, and this increase in information within the last five years is just increasing, it's going up at a very rapid rate.

MR. BAYLY: We'll show those to Dr. Martell, sir, and we'll be producing Stein in the flesh again.

THE COMMISSIONER: Oh you will, eh?

MR. BAYLY: You may want to address some of those questions to him as well.

THE COMMISSIONER: Mr. Stein worked in the valley, Steigenberger on the Yukon coast.

MR. BAYLY: That's correct, sir.

THE COMMISSIONER: Okay, well thank you very much, Dr. Martell. We appreciate your very comprehensive review of the impact of man on the life of the delta, and your suggestions regarding the

present state of knowledge. So, thank you again.

WITNESS MARTELL: Thank you.

(WITNESS ASIDE)

THE COMMISSIONER: And we'll adjourn the inquiry --

MR. GOUDGE: Sir, before we do that, just briefly so we'll all be clear, list the batting order for when we come back in Febuary. As I understand it, Mr. Bayly has a list of the material that he proposes to present to you, sir.

THE COMMISSIONER: Yes, excuse me, just so there's no misunderstanding, the Inquiry is meeting again tonight at 8:00 o'clock in this hall to hear the people from Inuvik who wish to speak and all of you are invited to return here at 8:00 o'clock tonight, and those of you who live here and wish to say anything about these matters may do so at that time, and I'll be pleased to hear from you.

The formal hearings are adjourned until a week Tuesday, at 10:00 A.M., and at that time we will carry on with a two-week session of hearings that will run right through to and including Saturday, the first week resuming the following Monday at 9:30, and running through until the following Friday. We'll keep the same hours we've been keeping during this session.

Now, Mr. Bayly will give us the batting order so far as he's concerned?

MR. GOUDGE: Yes sir.

MR. BAYLY: Sir, I have seven

panels left in this portion of the evidence that we've called the delta phase, for want of a better name, and what is left is a panel on the Beaufort Sea biology, containing approximately six people; a panel on the physical nature of the delta and Beaufort Sea, containing two people; Dr. Millen reviewing the Beaufort study, and in particular an offshore blowout scenario that was developed to look at the possible contingency plans available, and that's just a single person panel; a panel on exploration to date, of one person, and that is seismic exploration to date, on and offshore; a panel on some effects of exploration to date consisting of fisheries people, two people; a contingency planning panel of three people; and a community information program panel of as many as five people.

Now that doesn't necessarily mean that in all cases there will be a presentation from each person. Some of this evidence has been distributed; I anticipate we will have at least the evidence of Messrs. Sterling and Grainger distributed prior to people's leaving, if they're leaving tonight, and perhaps one or two more pieces before tomorrow if people are still here. We'll have to make arrangements for the rest to be distributed by airfreight or by whatever means, as soon as possible.

I would anticipate that with the amount of cross-examination there has been so far, that that may be able to be completed in that first week of formal hearings, in the next segment.

THE COMMISSIONER: Yes. Well,

Mr. Carter, Mr. Marshall and you should, bearing that in mind, be standing by ready to call your cross delta evidence.

MR. GOUDGE: I was going to suggest that, sir. The only other item that will be added to our plate in the next two weeks, is, well really two things that will be added; we will be expediting the attendance of certain government witnesses who will describe to you in general terms the regional planning process that is proposed for the delta region, we will also be expediting the attendance of certain government witnesses who will provide you with a general and accumulative environmental impact evidence, as they have it, of the gathering lines and gas plants on the delta.

Those witnesses will not be our witnesses in the strict sense, but they will be here and making presentations to you on those subjects, sir.

After that, I would anticipate that we would be able, in the second week, to get into the cross-delta application evidence of the applicant, Canadian Arctic Gas.

And the one other comment I would make sir, is that because of timetable difficulties, obviously we may require some slight adjustments and I know counsel will co-operate in filling any gaps that may arise through necessities of transportation.

THE COMMISSIONER: Right, so that will --

MR. BAYLY: Just on the batting

order sir, I am not quite clear when these witnesses that the Commission counsel is expediting will arrive and I would hope to have some word on that from them, if not today, as soon as possible.

MR. GOUDGE: Yes, I'll undertake to advise Mr. Bayly as soon as I know; I simply can't tell right now.

MR. LUTES: Mr. Commissioner, with respect to the two weeks which you are going to sit, when you said you were going to sit through Saturday, did you mean the Saturday after the end of the first week?

THE COMMISSIONER: Yes.

MR. LUTES: And you intend to adjourn on the Friday of the following week?

THE COMMISSIONER: Yes, that's just as we have done this session. If we sit right through to Saturday, then no one is tempted to leave for Calgary for the weekend, and --

MR. GOUDGE: No one is able to leave for Calgary sir.

THE COMMISSIONER: So, the formal hearings stand adjourned then until a week Tuesday at 10:00 in the morning, and the Inquiry is adjourned until 8:00 o'clock tonight.

(PROCEEDINGS ADJOURNED TO FEBRUARY 10, 1976)

MACKENZIE VALLEY PIPELINE INQUIRY

IN THE MATTER OF APPLICATIONS BY EACH OF
(a) CANADIAN ARCTIC GAS PIPELINE LIMITED FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE YUKON TERRITORY AND THE NORTHWEST TERRITORIES; AND
(b) FOOTHILLS PIPE LINES LTD. FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE NORTHWEST TERRITORIES,
FOR THE PURPOSE OF A PROPOSED MACKENZIE VALLEY PIPELINE

and

IN THE MATTER OF THE SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACT REGIONALLY OF THE CONSTRUCTION, OPERATION AND SUBSEQUENT ABANDONMENT OF THE ABOVE PROPOSED PIPELINE

(Before the Honourable Mr. Justice Berger, Commissioner)

Inuvik, N.W.T.

February 10, 1976

PROCEEDINGS AT INQUIRY

Volume 121

ALLWEST REPORTING LTD.,
4299 CANADA WAY,
BURNABY 2, B.C.

APPEARANCES:

Mr. Ian G. Scott, Q.C.,
Mr. Stephen T. Goudge,
Mr. Alick Ryder and
Mr. Ian Roland — for Mackenzie Valley Pipeline Inquiry;

Mr. Pierre Genest, Q.C.,
Mr. Jack Marshall, and
Mr. Darryl Carter — for Canadian Arctic Gas Pipeline Limited;

Mr. Reginald Gibbs, Q.C.,
Mr. Alan Hollingworth &
Mr. John W. Lutes, — for Foothills Pipe Lines Ltd.;

Mr. Russell Anthony &
Pro. Alastair Lucas
Mr. Garth Evans — for Canadian Arctic Resources Committee;

Mr. Glen W. Bell and
Mr. Gerry Sutton, — for Northwest Territories Indian Brotherhood, and Metis Association of the Northwest Territories;

Mr. John Bayly
or
Miss Leslie Lane — for Inuit Tapirisat of Canada, and The Committee for Original Peoples Entitlement;

Mr. Ron Veale and
Mr. Allen Lueck — for The Council for the Yukon Indians;

Mr. Carson H. Templeton, for Environment Protection Board;

Mr. David Reesor — for Northwest Territories Association of Municipalities;

Mr. Murray Sigler — for Northwest Territories Chamber of Commerce.

Mr. John Ballem, Q.C., — for Producer Companys;

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Inuvik, N.W.T.

February 10, 1976

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. GOUDGE: Perhaps I could put on the record four reports that have been received by our office in Yellowknife and which are in addition to those Mr. Scott put on the record the last time we were here. They're preliminary drafts of reports from the Beaufort Sea Environmental Program. We have copies available for the participants to consult if they wish, here in Inuvik.

The first is a report dealing with "Near Bottom Currents and Offshore Tides" by Huggett et al., That's H-U-G-G-E-T-T. The second deals with "Hydrodynamics of an Oil Well Blowout" by Topham, t-o-p-h-a-m-. The third deals with "Oil, Ice and Climate in the Beaufort Sea"by Walker and the fourth deals with "Movement and Deformation of Land-Fast Ice in the Southern Beaufort Sea", by Cooper. Those reports we have available for inspection.

MR. BAYLY: Mr. Commissioner, while we are housekeeping, I have four reports in the possession of COPE and I'll be sending out a letter to the participants, but I'll announce the names of those reports for the record in case the letter doesn't get out during the next week. The first one is by Dr. Peter Usher, "Evaluating Country Food in the Northern Native Economy".

The second is by N. Simmons

and T. Barry, "Oil Exploration and the Banks Landers". The third one is "The Application for Drilling Authority", volume one, Dome, Gulf and others. Tingmiaik, T-i-n-g-m-i-a-i-k, K-91 and Dome Hunt Kopanoar, K-o-p-a-n-o-a-r, D-14, volume 2; "Oil Spill Contingency Plan", Dome Petroleum Limited, and the fourth one is comments on the draft of Beaufort Sea project summary document entitled "Offshore Drilling for Oil in the Beaufort Sea", a preliminary environmental assessment, November 27, 1975.

Mr. Commissioner, if I could introduce this panel to you and then ask the members individually if they'd go over their qualifications. On the extreme left and working to the -- to your right sir, we have Dr. Percy, Dr. Grainger, Dr. Barry, Dr. Sergeant, Dr. Smith and Mr. Stein.

JONATHAN ARTHUR PERCY, sworn
E. H. GRAINGER, sworn
THOMAS W. BARRY, sworn
D. F. SERGEANT, sworn
THOMAS G. SMITH, sworn
JEFFREY N. STEIN, resumed:

DIRECT EXAMINATION BY MR. BAYLY:

Q I wonder if we could start with you, Dr. Percy, if you'd be -- they -- the witnesses have been sworn, sir -- if you'd be good enough to go over your curriculum vitae for the record.

WITNESS PERCY: Yes, I received by Bachelor of Science Degree from Carleton University in 1964; my Masters Degree from Memorial University in Newfoundland in 1968, and a PhD Degree from Memorial

University of Newfoundland in 1971, specializing in Marine Biology and Physiology of Marine Invertebrate

From 1971 - 72, I was a post-doctoral Research Associate at the University of Alaska, Institute of Arctic Biology, specializing in zoophysiology and at that time I participated in the cruise of the research vessel "R/V Alpha Helix" from the Scripps Institute of Oceanography into the Bering Sea.

Since 1972, I've been a research scientist in marine ~~physiology~~ biological oceanography at the Arctic Biological Station in Ste. Anne de Bellevue, Quebec where I'm specializing in environmental physiology of arctic marine invertebrates.

Q Thank you sir. Dr. Grainger, could go over your qualifications for the record, please?

WITNESS GRAINGER: I attended elementary and high school in Moncton, New Brunswick. I went Mount Allison University in Sackville, New Brunswick for a B.A. in 1947, then to McGill in Montreal for an MSc in 1949 and a PhD in 1953.

I am employed by the Fisheries and Marine Service of Environment Canada and have been for -- since 1953, during which time I've worked primarily in the Arctic. I am in charge of the biological oceanographic group at the Arctic Biological Station and at the moment, I'm serving as Acting Director of the Arctic Biological Station in Ste. Anne de Bellevue.

Q Thank you sir. Dr. Barry?

WITNESS BARRY: I attended the Rochester, New York school system. After release from the U.S. Navy, I received a Bachelors Degree from the University of Rochester and then a law degree from Syracuse University. After a spell as working for General Motors in Labor Relations and Industrial Relations, I guess I saw the light and returned to university, started all over again at Cornell University, where I got a Master of Science Degree, majoring in Wildlife Management and Animal Physiology, and later a PhD in Zoology at the University of Alberta.

I worked for the Canadian Wildlife Service for nineteen years. Most of my work has been in the Arctic; three years at Southhampton Island and around the eastern Arctic and then since 1957, I've worked out of this western area, out of Inuvik. I've lived in Inuvik for seven years.

During this time, some of the relative experience to this Inquiry, I did all the surveys and followed the descriptions all the way through to the Order-in-Council establishing bird sanctuaries across the western Arctic -- in particular, the Kendall Island Bird Sanctuary right here in the delta; Anderson River Delta Migratory Bird Sanctuary, two bird sanctuaries on Banks Island, one at Cape Perry and one at Queen Maud Gulf over much further east.

I've participated in various studies in this area. One was mentioned, the Banks Island study, which I guess is now released. I had them

for the Minister of Indian and Northern Affairs. I participated in the study of cultural and economic values of wildlife on Bathurst Peninsula for the people of Tuk. I don't know the status of that, whether it's still in Indian Affairs hands or not.

I operated a boat along the Arctic Coast for ten years -- twin engine -- twin diesel boat, so I've become fairly familiar with the coast between Herschel Island and Bathurst Peninsula . I participated in a study with a local person from Sachs Harbour a number of years ago on the wildlife values and use of various species of wildlife by native peoples of the Mackenzie Delta region, excluding Inuvik -- most of the out-settlements.

I'm now stationed in Edmonton, have been since 1970.

Q Thank you Dr. Barry. Dr. Sergeant, could you go over your curriculum vitae for the Inquiry, please?

WITNESS SERGEANT: I studied zoology, botany and geology at Cambridge University, U.K., taking an honors degree in zoology in 1948, and taking my PhD. in 1953 in the subject of experimental ecology of fishes. Since 1951, I have been with the Fisheries Research Board of Canada, now part of the Fisheries and Marine Service of Environment Canada, first stationed at St. John's Newfoundland Biological Station and later at the Arctic unit in Montreal which in 1965 became the Arctic Biological Station at Ste. Anne de Bellevue, Quebec.

I have studies the biology of the great whales on the East Coast of Canada, the harp and hooded seals of the East Coast and the arctic whales, white whale, narwhal and bowhead and their management.

I visted the delta in July-August, 1961, visiting Inuvik, Aklavik, Shingle Point and Kendall Island in travelling by aircraft and river-boat.

Mr. Hoek, who is a coauthor, with my submission, having carried out many of the later observations, is the technician working with me who joined the Arctic Biological Station in 1966, coming from MacDonald College, Quebec, where he worked in agriculture and entomology. He has visited the delta in 1968,1969, 1972 and subsequently every summer and several autumns up to 1975 inclusive, carrying out surveys of whales and studies of native people's whaling. He is presently studying French.

Q Dr. Smith, could you go over your qualification for the Inquiry, please?

WITNESS SMITH: I received my Bachelors Degree from Bishop's University in 1965, an MSc. Degree in limnology from this same university in 1968. I then attended McGill University where I received a PhD Degree in Marine Sciences, setting the population dynamics of ring seals in the Home Bay area of eastern Baffin Island. I received the degree in 1971.

I've been working for the

Arctic Biological Station at Ste. Anne de Bellevue since 1968 and I've been employed there as a full-time staff member since 1971.

I've done population dynamics studies of a ring seal out of Pangnirtung and Broughton Island on the east coast of Baffin Island and then moved the same type of studies over to Holman Island in 1971. We've been carrying out continuing studies in the Anderson Gulf area. Since that time, studies have branched out into other aspects considering predation of ring seals by arctic foxes and polar bears; and have developed into a -- into ecophysiological studies which we've been carrying out since 1972 on captive ring seals.

Q Thank you sir. Mr. Stein has been a witness before, sir, and unless you wish it I would not have him read his--

THE COMMISSIONER: I remember Mr. Stein well and I remember his testimony well.

MR. BAYLY:
Q All right. I wonder if we could begin with the evidence then of Dr. Percy, sir, and there are two portions to this. He'd be commencing with the one entitled "The Nature of the Threat of Oil Pollution to Marine Life".

WITNESS PERCY: This first section of the evidence is primarily a simplistic summary of some of the problems people have in working with oil in the marine environment and looking at oil impacts on marine organisms, to give you some idea of the reasons for the uncertainty that will become evident

in the second presentation a bit later.

The potential for a major oil pollution incident in the arctic has increased quite dramatically over the past several years and has led Dunbar to suggest that oil pollution is now the most serious and immediate threat facing the arctic ecosystem.

THE COMMISSIONER: Excuse me. Dunbar's name has come up before. Who is Dunbar? I know this must seem --

A Well, he might be considered the dean of arctic biology in Canada. He is presently at McGill University. I think probably Dr. Grainger would have more information on him, as Ted Grainger is a student of Max Dunbar's.

THE COMMISSIONER: No, that's fine for now. I -- forgive me, I had read, I think, some things he wrote, but he hasn't been a witness and that --

A No, I don't think so.

THE COMMISSIONER: -- That's our loss, to this point.

A This is particularly true for the arctic marine ecosystem now that emphasis is rapidly shifting to offshore drilling in the coastal waters of the Beaufort Sea. The technological feasibility and potential hazards of such an undertaking are subjects of continuing debate and speculation, as you all well know. Particular concern has been been expressed for climatological and ecological con-

sequences of major submarine well blow-outs. The glaring inadequacy of our present understanding of both short and long-term effects of such accidents has been brought into sharp focus by this continuing debate. Our ecological ignorance has made it difficult to realistically sustain or even to convincingly refute the many highly speculative predictions of widespread environmental disaster, and I'm sure many of you have seen a lot of these predictions that have been sort of off-the-cuff predictions of what would happen if there was an oil spill.

As Dunbar again, so aptly puts it, "we have been caught in a state of scientific near nudity in the particular respect in which we now so urgently need protective covering; namely knowledge of what the proposed developments will do to the environment in precise terms, and knowledge of what should be done to conserve and protect."

As you can well imagine, near nuditiy in the arctic is not a particularly comfortable state, be it scientific near nudity or actual near nudity.

THE COMMISSIONER: Well, Dr. Percy, Dunbar said that in 1971, I gather from your statement.

A Right.

Q Does he still subscribe to that point of view? Is it one that he would regard as applicable today?

A In general, I would think, yes, discusssions with him, I think he'd -- there have been advances, certainly, as I'll make -- as I'll point out a bit later on, but I think the general statement still holds a lot of water.

This general uncertainty is unquestionably compounded by the fact that little reliable information is available about even basic ecology and physiology of the overwhelming majority of arctic marine species. This creates problems in the effective conduct and proper interpretation of experimental studies on interactions between crude oil and arctic organisms. Furthermore, it makes it especially difficult to assess the applicability, in the artic context, of generalizations about oil ecosystem interactions derived from numerous studies conducted in temperate and tropical marine areas.

Even in temperate waters where intensive research has provided a solid information base, it is still impossible to predict, with any degree of confidence, the precise ecological effects of an anticipated oil spill. Even after an oil spill has occurred it has proven very difficult to assess the overall detailed environmental impact. Given the dearth of information about arctic marine ecosystems, attempts at detailed impact prediction at present can be considered as exercises in futility.

Ecological concern has thus far been centered primarily upon those components of the

ecosystem that are of direct present or potential economic importance to northern residents, particularly marine mammals and water fowl. Although one should not underestimate the importance of gaining as complete an understanding as possible of direct effects of oil on these economically important animals, it would be particularly short-sighted and potentially rather dangerous, to confine our attention to just these species. They do not and cannot exist in a vacuum but are part of a complex ecological web characterized by a multitude of vital interdependencies, as you will see a bit later on, as these presentations emerge.

Thus far, little attention has been paid to those "low profile" organisms of little direct economic consequence that nevertheless, form a critical part of the ecological web upon which higher forms are dependent.

It's generally conceded that recovery from a severe ecological disturbance, such as a major spill, would be a lengthy process in the Arctic. This is a consequence of the slow growth, extended life cycles and longer reproductive periodicity of Arctic animals as well as the slow dispersion and degradation of oil at the lower temperatures. However, it is still not quite clear just how susceptible various components of the Arctic marine ecosystem are to damage by oil pollution in the first place.

In view of the great complexity of potential interactions between oil and animal communities, it would be manifestly impossible in a study of

limited duration such as I will report on in the second portion, to explore then a few of the -- to explore more than the few -- than a few of the many aspects of the problem.

Unlike many other pollutants, crude oil is relatively insoluble in seawater and creates the first of the problems. As a consequence, spilled oil does not spread uniformly through the environment but tends rather to concentrate in specific areas of the environment in a variety of different forms. Marine organisms -- marine organisms may thus encounter varying concentrations and forms of oil, depending upon their habitat and circumstance. The habitats I'll specifically be mentioning a bit later on are the inter-tidal, the sub-ice , the water-column habitat and the bottom habitat and each of these habitats have specific species associated with them and each of these habitats is subject to oil in different forms and in different quantities and so the animals living in them are going to experience different effects of the crude oil.

Interaction of animals with oil in any of the above forms in habitats may result in three distinct levels of effects. The threshold concentrations for each of these levels differ quite considerably. Generally, we can distinguish the -- first, the short-term lethal effects in which the animals succumb quite rapidly and usually fairly high oil concen-trations are involved in this type of damage, concen-trations in the high parts per million and low parts per thousand range are involved.

Secondly, we have sub-lethal physiological effects which don't result in rapid death of the organism but involve major modifications in a variety of physiological processes that may prove lethal in the long term. Such effects generally become apparent at oil concentrations much lower than the lethal effects and we're talking about here in the high parts per billion and low parts per million range, and these are just generalized ranges at the moment.

Thirdly, we have a class of effects that are only just now even in temperate waters, beginning to be closely studied so we don't know too much about them, but they look as though they could be fairly important. These are behavioral-integrative effects which may not directly involve major physiological disruptions in the organism but are reflected in the inappropriate behavioral responses to either biotic or abiotic factors in the natural habitat, either as a direct result in response to the presence of oil, or as an indirect effect resulting from the masking or mimicking of natural chemical cues by specific components of the oil. For these effects to occur, concentrations in the low parts per billion range may be sufficient to evoke responses and have been indicated in a number of studies.

Oil pollution biology is a relatively new and active field as evidenced by the rapidly accumulating literature on the subject. Virtually all of the available information at present on the

effects of crude oil on marine organisms in communities is derived from studies involving tropical and temperate ecosystems. The purpose of this present summary is not to provide an exhaustive survey of this growing literature, but rather to present a general conceptual framework upon which the fragmented information about oil effects on the Arctic marine environment can be viewed to maximum advantage.

Few Arctic oil spills have been studied in sufficient detail and for a long enough period to realistically assess the environmental impacts of such incidents. A complete absence of pre-spill baseline date has, in most instances served to further compound the uncertainty. Impact prediction is rendered virtually impossible by the fact that little reliable information, as I pointed out before, is available about the basic ecology and physiology of the great majority of Arctic marine species.

Any discussion of oil impact in the marine Arctic must necessarily, therefore, rely heavily upon information accumulated in the many excellent follow-up studies of oil spills in temperate seas and in the many laboratory studies that have been conducted on temperate species. However, a considerable caution is required in using this temperate derived information in the Arctic context. Several features of the Arctic marine ecosystem may have an important bearing upon the ecological consequences of an oil spill.

Major crude oil spills in temperate waters such as the Santa Barbara spill in

California and the Torrey Canyon spill off the southern coast of England, killed large numbers of birds and intertidal invertebrates, but were not as ecologically devastating to animals in the water column as anticipated. However, this should not make us overly complacent about the potential impact of comparable oil spills in the Arctic Ocean.

I'd like to consider now, some of the various factors that influence the environmental impact of an oil spill. Studies on the impact of petroleum pollution upon marine ecosystems often yield conflicting and inconclusive results that make it very difficult to establish general principles. That this is so, is largely due to the very complex nature of the pollutant, both in its chemical and physical charcteristics, and to the diverse physiological responses of different types of organisms to various components of the oil.

Much of the difficulty in predicting oil spill effects is attributable to the fact that the ultimate fate of each spill is determined by several interacting variables, each of which may play a lesser or greater role in influencing the impact upon the ecosystem. Several of these factors are common to Arctic and temperate oil spills, others have important Arctic aspects while some have features that are particularly unique in the Arctic context. For convenience, I have separated them into physical and biological catagories.

The physical factors that are

important are:

1. Type of oil
2. Dose of oil
3. The manner of introduction of oil into the environment.
4. The physiography and hydrography of the spill area.
5. The season of the spill.
6. Weather conditions, and,
7. The method of treatment.

Some of the important biological variables include:

1. The season of the spill, in relation to the to the biological components.
2. Adaptation effects.
3. Interaction or synergistic effects.
4. The nature of the biota present in the area, and,
5. The precise mode of interaction of the oil with the animals.

It's the interaction of all these factors in the Arctic marine environment that will determine the overall impact of any given oil spill. In some spills one or two of these factors may assume an overwhelming importance in determining the magnitude of the impact. For example, just to cite a few examples of this, in the Torrey Canyon spill, the method of treatment was one of the principle contributing factors to the damage that was observed. In the Buzzards Bay oil spill, near -- in Massachusetts it was the type of oil that was particularly damaging because it was a very toxic refined product. In the "Tampico Maru" oil spill, off

the coast of California, it was largely the physiography of the spill area that was the most -- was the determining factor because the spill occurred into a small cove that was then effectively blocked by the tankers so the oil was confined in this small cove, so this was the prime determing factor in that situation.

I'd like to briefly discuss some of these factors from the point of view of oil spills in Arctic waters, the physical factors I'll go over fairly rapidly because I'm not really that competent to interpret the -- some of the physical effects, but I will just mention some of the variables.

The type of oil, firstly. The type of oil spilled in an accident clearly has a major bearing upon the magnitude of the resulting ecological impact. Petroleum pollutants generally fall into two very broad categories. Non-persistent pollutants include the lighter refined components such as gasoline, kerosene, diesel oil, etc., that have generally been found to evaporate rather quickly following a spill. Persistent pollutants such as crude oil, bunker fuel, etc., have a large bulk of heavy components that may remain in the environment for an indefinite period of time. In the absence of far northern refining facilities at present it is the latter type of pollutants that are the most serious threat to Arctic ecosystems. It is generally assumed that the toxicity of refined products is greater than that of crude oil, however Butler and Berkes, after an extensive review of the literature suggest that the available data does not warrant such

a conclusion. Shelton, however, maintains that apart from the light refined components, petroleum products are not highly toxic. This would also appear to be the general conclusion to be drawn from the extensive series of studies that followed upon the Torrey Canyon incident in which crude oil was spilled. However, toxic effects of crude oils have been widely reported and much of the confusion evident in the above few sentences no doubt arises from the fact that different types of crude oil vary quite extensively in their toxicity, as Ottway has clearly shown for several species of intertidal organisms, and as Kuhnhold has similarly shown for crude oil toxicity to herring eggs. Up until the present Beaufort Sea study we had no real indication of the relative toxicity to Arctic marine organisms of northern crude oils.

The second physical variable is the dose of oil. That the quantity of oil spilled in a given incident markedly influences environmental impact is so obvious that little comment is required. Other evidence has been presented, I think, that indicates the potential dose involved in the quantities of oils that are being considered in the present situation.

Thirdly is the manner of introduction of oil into the environment. The fact that the oil will be released into the water from the sea floor under very high pressure, rather than released relatively passively onto the sea surface, is likely to have important consequences in regard to the distri-

bution of oil in the various parts of the environment, that I mentioned before.

Fourthly, the physiography and hydrography of the spill area. Coastal configuration, current flows, tidal conditions and physical characteristics of the water column will all play a major role in determining the magnitude of the area of the marine environment affected by a major spill.

Fifth, is the season of the spill. That the seasonal changes in certain physical parameters such as temperature or ice-cover, may influence the impact of an oil spill is obvious. Not so obvious is the fact that the susceptibility of animals to certain pollutants may vary considerably with season as a consequence of changes in the physiological conditions of the animals and this has been shown in a number of studies in temperate waters. Nothing, however, is known about seasonal variations in the sensitivity of Arctic animals to crude oil.

Next are weather conditions. Obviously, weather conditions at the time of a major spill, particularly such factors as wind speed and direction, will play an important role, not only in determining the magnitude of the area affected, but also by influencing sea state in determining the quantities of oil mixed in the water column.

Next is the method of treatment. The manner in which the spilled oil is treated during clean-up attempts is an important feature in determining

biological impact. This was one of the major lessons learned from the Torrey Canyon spill, where the use of dispersants appears to have caused more ecological damage than did the oil itself.

Next are the adaptation and synergistic or interacting effects. Adaptation and interacting effects may subtly modify the impact of oil pollution on a given marine population. Studies in temperate regions suggest that some species can adapt to continued low exposure or continued exposure to low levels of petroleum and thus exhibit greater tolerance to more massive doses, and the particular study that I'm referring to here is one that was done in California where there are certain natural oil seeps and it was found that animals from these oil seep areas appeared to be able to tolerate oil more readily than animals from non-seep areas. This is still a point of considerable contention, but it does appear to occur in certain species.

On the other hand, prior or simultaneous exposure of the animals to other types of pollutants may serve to increase the animals susceptibility to petroleum. This is just a case of imposing one pollutant stress upon another pollutant stress. However, in view of the relatively unpolluted state of the Arctic Ocean, neither pre-adaptation nor interacting effects are likely to play significant roles in modifying responses to oil spills.

Next is the nature of the biota.

There is a marked difference in the ability of different types of animals to tolerate the presence of oil in their environment. Even allowing for the different types of oil and different preparative and experimental techniques, one is forced to the conclusion that certain species can thrive in incredibly high concentrations of oil, while other species are killed or severely stressed by even a hint of petroleum in their environment. The precise reasons for this remarkable difference in tolerance are not, at present, know; largely due to the fact that we have no very clear idea of which components and what mechanisms of toxicity are responsible for the irreversible damage to organisms exposed to a given crude oil.

Data on sensitivities of various species to oil pollution have been derived from two different sources; field observations following accidental or controlled oil spills and laboratory toxicity studies conducted under standardized environmental conditions. The former are usually difficult to interpret because of lack of controls and the potential involvement of a wide range of uncontrollable environmental variables that may modify the overall response of the oil.

On the basis of the available data, it is difficult to draw hard and fast generalizations regarding the oil tolerance of various classes of invertebrates. Difficulties in making comparisons arise from the fact that differences in the tolerance of species are obscured by differences in the oils involved, differences in method of application of the oils,

differences in the degree of weathering of the oils, in addition the differences in a variety of other environmental parameters.

The last variable is the mode of interaction of oil with the organisms. The manner in which the spilled oil interacts with the organisms is an important factor in the overall impact of the oil spill. As I pointed out earlier, crude oil, unlike a lot of other pollutants, does not spread uniformly through the environment from its point of release, so the dose of oil to which a given population of animals will be exposed varies considerably, and often unpredictably in different parts of the ecosystem.

The physical form, eventual fate and ecological effects of spilled crude oil will differ greatly depending upon whether the oil is deposited in the intertidal zone, dispersed in the water column, absorbed into the bottom sediments or accumulated in pools under the ice.

I'll discuss some of these particular habitats and the impact of oil in the later presentation.

Now, I'd just like to review some of the biological effects of crude oil and break down some of the generalizations that I made a bit earlier.

Blumer, in reviewing some of the potential biological effects of oil pollution in marine ecosystems, suggested that adverse effects upon organisms can be conveniently grouped into the following

general categories.

Firstly, the direct kill of organisms by physical effects such as smothering or being trapped in the oil.

Secondly, the direct kill of organisms by contact toxicity, that is, by toxicity by components that have low solubility in seawater.

Thirdly, direct kill of organisms by seawater soluble components.

Fourthly, destruction of sensitive larvae and eggs by any of the above mechanisms.

Fifth, destruction of the food resources of the particular species you're considering.

Sixth, Sublethal effects resulting in direct long-term mortality or in reduced tolerance to normal environmental stresses.

Seventh, interference with subtle behavioral and integrative mechanisms of individuals, populations or communities.

Eight, incorporation and possible concentration of carcinogens and other potentially toxic compounds in the food chain.

The greatest emphasis thus far has been placed upon short-term lethal effects of the types outlined in the categories one to four above. Toxicity tests have usually involved either immersing the animals in whole oil for specific periods and then returning them to clean seawater, or more

realistically, exposing groups of animals to graded seawater dispersions or water soluble extracts of crude oil for specific time periods and this is classically the 96 hour toxicity test which is sort of a standby of pollution biologists.

However, recently there has been a growing awareness that short-term lethality is an overly gross criterion for assessing ecological effects of pollutants. Useful as these 96 hour bioassays have been in investigating certain aspects of pollution impact, they can never be considered as more than crude first approximations. Increasingly, emphasis is shifting to a variety of subtle sublethal effects that impair the organisms' ability to function effectively. Prolongation of such impairment may, in time, lead to the reduction or elimination of populations in the affected area. These physiological effects are often difficult to detect and only recently has there been a general appreciation of the many insidious forms that they may assume. Warner, and others, have suggested that pollution biologists should be more concerned with "toxic response syndromes", which is a complex of diverse behavioral, physiological and biochemical parameters, rather than be so hung up on the 96 hour lethal bioassay.

There is now limited but convincing evidence that crude oil released into the environment not only disrupts normal physiological functions of individuals, but may also interfere with

complex behavioral patterns necessary for effective integration of the various components of an eco-system. This may be a consequence of a direct response to the presence of oil or an indirect effect resulting from the masking or mimicking of natural chemical cues by certain soluble components of the oil.

Kittredge, and others, have pointed out that the effects of the latter type could impair the organisms ability to locate food, to locate a suitable niche or sexual partners and various other subtle effects. However, before further advances can be made in this area by pollution biologists, it will be necessary to have much more comprehensive information on the utilization of these natural chemical cues by marine organisms and this is a fairly young and growing field so the pollution aspects of it are even more uncertain at present. But the indications are that it is a significant phenomenum.

THE COMMISSIONER: Dr. Percy, when you're conducting an Inquiry like this as I am, you have to say to yourself from the very beginning that you will not be afraid to ask stupid questions and, confronted with people of your competence, I'm afraid that sometimes I have to ask questions that may seem pretty elementary to you, but I'll continue to do so. Would you mind just telling me -- you said that there were three areas of the waters that were important. You said the intertidal area, which I comprehend, the water column, which I don't think I do and I'd like you to tell me what that is.

A Basically I split it up into four areas. What I've tried to do is generally assume that if we dump oil into sea water that you're getting so much oil and so much sea water and it has an impact on the ecosystem. What I've tried to do, is to emphasize the fact that this oil is not dispersed uniformly through the ecosystem; it's getting into specific parts and in those parts there are various organisms in these habitats that are likely to be affected. The four sections that I split it up into, and this is sort of a fairly rough splitting, is the inter-tidal zone, the sub-ice community which is the -- which I'll be expanding a bit later, the water column which is the water between the surface and the bottom, and then the bottom community, the sediment community and there are animals living in all of these various zones.

Q All right.

A And I'll be expanding a bit more in the second portion on these various communities.

Q I thought that was what you meant, but I wanted to be sure. Now just one other thing and maybe you'll be coming to this later, but I suspect there may well be others in the room who don't understand fully what masking or mimicking of natural chemical cues amounts to.

A Well, to give you an example, one of the studies that was done on investigat-

ing this particular point involved the feeding responses in crabs, and it's known that certain chemicals in the water column generally released by the prey organism induce a feeding response in these crabs. Now if the animals had been exposed to very low concentrations of oil in the water column they were unable to detect the presence of these prey chemicals in the water. In other words, it didn't induce their normal feeding response. That's essentially masking of the normal chemical cues present in the environment.

We're only now really learning about how wide-spread these chemical cues are. A lot of organisms rely on these water-borne chemical cues for various functions, and various components of the oil -- and you've got to remember, too, another important point is that oil consists of thousands of different organic entities, it's not just a nice well-defined entity, and a lot of these are organic components that interfere with the organisms' normal chemo- sensor responses.

Now the other aspect that I mentioned was mimicking, and perhaps the best example of this I can give is a fairly well-known fact that lobsters are attracted to certain components of kerosene, and I gather from speaking to various people down the east coast that lobster fishermen frequently make use of this, they soak kerosene or use kerosene soaked rags in their traps. This, presumably some component is being perceived by the lobsters, something

comparable to food, it's receiving a chemical cue from some component of this oil and it's responding as though it were a chemical cue for food. This, in fact, was one of the suggestions why there was such a massive lobster mortality in conjunction with the Woods Hole oil spill, or the Buzzard Bay oil spill, is that the lobsters were in fact attracted to this because it was mimicking what they would normally respond to as a natural cue.

THE COMMISSIONER: All right, thank you very much.

MR. BAYLY: Q Mr. Commissioner, I propose to ask Dr. Grainger if he would read his evidence next and we'll come back to Dr. Percy after that. Dr. Grainger?

WITNESS GRAINGER: The Arctic marine environment is characterized by cold water, the sea ice cover which prevails over a large part of each year, by little penetration of sunlight beneath the sea surface during most of each year, and by a very highly developed seasonality in a large number of features.

These features are the ones perhaps more than others, at least which set the Arctic marine environment aside from warmer water regions all over the world.

I'm going to refer now to a figure, figure 1, which I attached to the copies, and perhaps if you look at the figure rather than following

the words in the text it will become more meaningful to you. The object in drawing the figure is to show you in this form something of the structure of the ecosystem, which was referred to by Dr. Percy a number of times, a few minutes ago, and to relate different elements of it into a single hole.

In the figure then, the horizontal scale shows the span of a single year, running from January on the left to December on the right, and the vertical scales show various of the qualities measured. Quantities may be ignored on the vertical scale , the point of it all is that that is increased as we go up the scales from the bottom toward the top.

In the lower left in the figure the thickness of ice cover and snow cover over the ice are shown to reach their maximum during May, and then to fall off rapidly in June, and the ice disappears according to this picture by July. With the thinning of the ice, sunlight penetration of the water increases, in fact the sun begins to penetrate through the surface of the sea and this is shown in the figure as light at a depth of five meters. Again this is simply arbitrarily chosen. Consider that as light under the surface of the water. The peak of this quantity is reached in July, as the ice disappears. It's fairly obvious, I think, that without an ice cover the peak of this would occur around the 21st of June, which of course is the time when daylight is greatest during the year. It then falls off gradually after the

date indicated on the figure.

With the increase in the availability of light beneath the surface of the water, the small single-celled marine plants, the phytoplankton shown here as chlorophyll a on the figure, these grow and reproduce and reach their seasonal maximum in quantity soon after maximum light is reached. These plants undergo photosynthesis, in which they use the energy of available sunlight to convert inorganic chemicals present in the water into organic materials which in fact is themselves, and in which they produce oxygen.

One of the inorganic substances they use is a compound containing nitrogen and this is shown as nitrate in the figure. This increases in quantity during winter in the sea, as indicated, when plant activity is almost totally stopped under the sea ice cover. There is production but almost no utilization. With the development of plant activity in May - June, nitrate begins to decline in quantity and continues to do so until the plants reach their peak in August. The plants -- the chlorophyll a, again, in the figure, are the food of the small plant-eating or herbivorous zooplankton.

These increase their numbers with the production of young animals as plant food becomes available in early summer and the numbers fall off through the late summer and autumn, as shown in the figure. The decline in chlorophyll in this figure

was probably mainly a result of predation by the zooplankton -- of the plankton feeding on the plants. The fall in numbers of zooplankton was, in turn, probably initiated by larger animal eating carnivorous zooplankton and fishes which are not shown in the figure. Toward the right of the figure then, through October and November, winter conditions developed once more. In December the sea ice cover formed, began to grow and we were back close to the situation shown in the previous January.

The several stories shown in this figure, all of which are bound together and part of the much larger one, are not based upon data obtained in the Beaufort Sea, but the great seasonality indicated by the high peaks and the low dips in the figure, and the major lines of dependence in the Arctic region shown here, certainly relate, very obviously to the Beaufort Sea. Our study in the Beaufort Sea didn't allow the presentation of this kind of year-round information, in fact, which came from the eastern Canadian Arctic.

No part of the actual Beaufort Sea Project open-water study, and this applies to the work undertaken in 1974 and 1975, as part of the project which I was concerned in, was carried out under favorable circumstances. The ship-supported surveys of the two summers failed so badly to achieve the schedules planned for them, that most of the data strength of the study originated therefore, either in the year preceding the initiation of the Beaufort Sea project or through the use of helicopters on the early summer sea ice cover.

This was largely the consequence of sea ice persisting over areas where studies from shipboard had been planned. It had important consequences to this study showing in a very clear way, the fallacy of underestimating the Arctic by presupposing a capacity to perform in it under all conditions.

THE COMMISSIONER: Did that, Dr. Grainger, I understood in 1974 the sea ice persisted longer than had been expected. Was that so in 1975 too?

A Both yes and no, if that's fair. There were problems locally with sea ice which we experienced in our ship as a consequence of which we were unable to complete or even to visit most of the planned station points.

THE COMMISSIONER: Dr. Pimlott said, and I recollect being in the delta in the summer of '74, and, he said that in that summer -- that was the summer when summer virtually didn't come to the Beaufort Sea. Last summer was a normal summer in terms of the general climatic conditions, but I gather that localized conditions prevented you from carrying out the work you planned to. Is that what you are saying?

A Yes. We had a period planned for use of one of the ships and while I believe the weeks preceding our use of the ship were quite clear from the point of view of ice, during the few days we were onboard much, at least there was a large shoreward movement of pack ice which, during that period of time, prevented our visits to the planned points.

The present investigation did,

in fact, not achieve it's expectations in terms of range of coverage either in space or in time. And a number of rather elementary questions concerning base-line features of this system therefore, remain unanswered. The essentially base-line studies which I'm reporting on here were concerned for the most part with the sequence of relationships shown in figure one. The "lower" end of the ecosystem on which the fishes, sea birds, seals and whales are to such a great degree dependent.

It must be pointed out here, even though the physical oceanographers may already have done this or may, in fact, now be doing it in the future, but much of the coastal portion of the eastern Beaufort Sea is estuarine in its nature. This means that the relatively warm -- in the summer - fresh water of the Mackenzie River, flows beyond the river mouth largely over the colder, saltier, and therefore heavier, water of the Beaufort Sea. This area of visible river influence, made especially obvious in the Beaufort Sea by the heavy silt load carried seaward by the Mackenzie, is highly variable in its size, shape and location. Driven offshore by southerly winds, it is at its largest and it extends under those conditions farthest from shore.

Following onshore winds, the fresh water area is reduced in extent and forced shoreward, often close to the Tuk Peninsula coast. Largely because of its silt load, light penetration is greatly inhibited in the low salinity water just off the river mouths. Outside this area of primary river influence,

the clear oceanic waters allow fairly deep penetration of light. Whereas in the river water region, nutrients are abundant -- nitrate for instance -- having been contributed by river flow, they are largely useless in terms of supplying nutrients to the plants because the silt of the water at that point inhibits the penetration of light and consequently the plants are unable to carry out their photosynthesis and hence to use the nutrients which are present.

Beyond the area of river influence, the river plume,generally sufficient light in summer is accompanied by low nutrient values. Once the relatively small winter produced supply is used up, the surface waters become nutrient poor. So after the first bloom of spring, plant production largely stops because of nutrient deficiency.

The second figure, figure 2, shows light penetration in the southern part of the Beaufort Sea. The area of primary river influence is shown by the low values (one and less) off the delta and off the Tuk Peninsula coast, and the offshore waters by much higher values -- as you can see by looking at the figure -- there are values up to sixty, fourty and so on, beyond the river plume.

In figure three, which shows nitrate in the upper five meters of the water, that is, between the surface and five meter depth. Nitrate - nitrogen near shore is shown to be highest in approximately the same area as the low light penetration was shown in the other figure, that is to say, just off the river

mouths. Much lower values are seen farther offshore.

The high values, then, coincide largely with the area of low light penetration; the low values with the area of deep light penetration. In the first named regions, the material is not utilized to any great degree by the plants. In the second area offshore, it is used effectively and rapidly by the plants .

Now we can't at present show the -- in any detail -- the geographical distribution of production of plants in the south Beaufort Sea because we weren't able to collect the data adequately to present it that way. But indirect evidence points to lowest values of plant production in the nearly fresh, silt laden waters just off the river mouth. Farther offshore, beyond the river influence, production also seems to be low during much of the summer, for reasons I've already explained.

Quantities of plant material in summer are fairly consistently low on the basis of chlorophyll a measurements, in the area of study in the Beaufort Sea. This determination of low, by Arctic and by world standards and the values we found in the Beaufort Sea average, for instance, about one fifth those which we found, at the same time of the year, in a fully marine Canadian Arctic area in the eastern Arctic of Baffin Island -- approximately one fifth the average values.

The small zooplankton animals were distributed quantitatively as shown in figure four,

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Sergeant, Smith, Stein
In Chief

which is the last figure. In this, the numbers of organisms per unit of water sampled, are shown by circles of five sizes. The legend is on the top -- the largest black circles indicating the largest numbers and the smallest, the smallest numbers.

The highest numbers of individual zooplankton animals were found in the coastal bays; the lowest numbers, nearest the river mouths, and far offshore. Intermediate distances offshore showed intermediate values. Now some of the levels measured were high by Arctic standards -- the large circles onshore indicated very dense populations of species -- of specimens -- but the great majority were low by all regional standards, and in fact, bore a similar relationship to the Baffin Island quantities, as was shown by the plants above.

So, it is suggested on the basis of this kind of information that the south Beaufort Sea is a region of low marine production.

Now, considering for a moment some of the more specific studies which were related to this kind of work; crude oils evidently had no effect upon rates of nitrogen fixation of bacteria of the Beaufort Sea substrate -- the bottom of the Beaufort Sea, which is to say that the capacity of the bacteria to transform the element nitrogen, in which form it is not useable by plants, to a form in which it becomes available to parts of the biological cycle, does not seem to have been altered by short term exposure to oil, based

on experimental work carried out. Natural fixation rates appeared to be extremely low in Beaufort Sea samples, but were experimentally accelerated by the addition of carbon compounds, showing a potential which the natural conditions evidently did not allow to be realized.

In a similar way, denitrification, which is the return to elemental nitrogen, from the useable nitrogen compounds, was unaffected by oils, as was carbon dioxide production. Carbon dioxide production was measured here simply as a means of showing general metabolic activity of the bacterial cells.

Examination showed an abundant population of heterotrophic bacteria. That is, bacteria utilizing complex organic materials in their metaboloism. The large population was shown to have oil degrading potential in the Beaufort Sea. Largest cell counts were made in surface river water north of the Tuk Peninsula. Laboratory culturing showed that all the areas of the Beaufort Sea sampled supported bacterial populations with a potential for biodegradation at 5°C. In fact, a biodegradation potential was found at as low a temperature as -1°C. Nitrogen may be the principal limiting nutrient affecting metabolic activity of these bacterial organisms.

The effects of four types of crude oil -- Atkinson Point, Norman Wells, Pembina and Venezuela -- on phytoplankton productivity rates varied from inhibition to stimulation, depending not only on the species of plants, but as well on location, duration of the experiment, concentration of oil and the use of

dispersants. The use of Corexit with crude oils generally inhibited productivity.

Two seaweed species were examined for the effects of oil and productivity of both was found to be significantly inhibited by all types and concentrations of oils tested.

The threads that tie these studies together are the lines that run through the ecosystem under study, the fundamental dependence of each level upon those below it in the system structure. A major line of energy transer is the food chain , and this is a pathway for pollution. The primary plants utilize inorganic nutrients (nitrogen,phosphorus, silicon) and sunlight in the synthesis of organic material. This was mentioned a few moments ago. These, in turn, are the prey of plant-eating zooplankton, mainly small copepods. Next, come the predatory zooplankton -- the carnivorous -- a few larger copepods, but mainly jelly fishes, comb-jellies arrow-worms and other large predatory forms, and finally, pelagic fishes in the Beaufort Sea, principally the Arctic cod.

Other fishes prey on larger zooplankton and on small fishes, and the mammals on the larger invertebrate animals and on fishes. Within this scheme of things, the bottom-dwelling invertebrates exist and they subsist mainly on the rain of detritus from above and on other elements from the plankton above, as well as on each other -- and of course, they are the prey of the larger bottom animals, including fishes and bottom-feeding mammals.

It is a characteristic of cold northern waters that the number of species of plants and animals is small, relative to what is found in warmer seas, but that proliferation of individuals of certain of the few species is great. Hence, we have a small number species, a few of which are dominant and account for the large majority of the individuals. This is a simple system, at least according to one method of assessing simplicity, compared to one in which the total diversity is greater and none of the species is dominant. Relationships based upon who eats whom are simply illustrated in the Beaufort Sea. They show that the chains are usually short and have few links. Typical sequences are diatom -- this is a plant, phytoplankton cell -- diatom to copepod to fish. That's a three linked chain. Diatom to copepod to amphipod to seal; flagellate to euphausiid to whale, that sort of thing. Options in these energy pathways are few and vulnerability is therefore high.

One extremely important part of the system, significant in food chain building, is the under-ice biota. This is a feature of Arctic seas, the response to the ice cover which overlies the sea for a long part of each year. A special flora, comprised of diatoms, develops under the ice as winter progresses and the ice thickens. Evidently using nutrients available in the ice, the cells grow and divide, forming dense concentrations on and just within the lower surface of the ice. These plants may account for a significant proportion of total primary carbon production in a region,

over a year. The flora provides a large upside down feeding surface for small planktonic animals and forms the base of a food chain which includes the Arctic cod, probably the most important pelagic fish in the Beaufort Sea, as well as seal and whales.

Fixed in position, rather like an upside-down sea bottom community, the under-ice flora would appear to be highly vulnerable to oil effects, on the basis of a total lack of avoidance capacity and of the effects of oil on most plants cultured in the laboratory, as this has been shown in the experimental work done so far. If significant disruption of the under-ice flora occurs, then the effects may be expected fairly quickly to extend through the ice-based food chain.

Partly fixed in position are many members of the sea bottom fauna. Some move only very slowly, hence have only low capabilities for avoidance. Some move fairly quickly, but even they are restricted to a two dimensional surface, and cannot leave it, at least for any significant length of time. Especially in shallow bays, these populations are in a highly vulnerable position as a consequence of oil impact. Their role as food is particularly important to the bottom fishes and perhaps to diving birds and sea mammals.

It's been suggested before that biological systems are complex and highly variable. Of course they are. Whole systems undergo seasonal and annual variations. More troublesome are the highly individual variations found in different species and within single species at different periods of their cycles

and under an almost overwhelmingly large number of other variables related to their physiological conditions and their external circumstances. This point was made a few minutes ago, of course, by Dr. Percy.

As a start, it is absolutely essential that we derive a considerable degree of understanding of undisturbed or "normal" systems before we can appreciate many of the impact effects in any full sense. There is a requirement here for a great deal of work which must extend over a fairly long period of time.

In the Beaufort Sea and in most of the remaining marine areas of the Canadian Arctic, there are requirements to study ecosystems over periods of several years, and in all seasons of those years, to demonstrate normal annual and seasonal variations in all levels of the systems, and to define the major governing factors which make the systems go.

Superimposed over this are studies designed to respond to specific anticipated impacts, many of them, in their relevance to a particular system, dependent upon knowledge of the basic system itself.

In the Beaufort Sea, for instance there is no evidence at present that crude oil contamination of short duration will influence nitrogen fixation or denitrification by bacteria in the sea bottom. There is, however, the possibility of long -term effects, and there is a need for examination of this possibility. This is a recommended future task, important in any case

but with the significance possibly increased by our knowledge of the long term natural rates of these activities in the sea bottom, their dependence upon variable nutrient supplies, and their overall role in the biology of the system, all matters about which we know very little, at the moment. Here a recommended impact study could be greatly enhanced in its significance by additional work of a basic nature. The two approaches are not at all clearly distinguishable; in environmental studies, they may, in fact, be quite intermixed.

There is a requirement to learn about rates of degradation of oil by bacteria under varying circumstances. How large a spill may be reduced during what time period? There is a direct potential impact effect in this. But, assessment of destruction rates is also dependent upon the basic populations present at the time of impact and upon the factors which control bacterial populations in the natural system.

There is a special need to study biodegradation under the sea ice. At present, we have no knowledge about bacteria naturally occurring there, and we must learn about them as part of the normal system.

Crude oils inhibit productivity and growth of phytoplankton under many but not all circumstances, in the laboratory. There is a need to understand these interactions. Effects of stress may be expected to vary widely, on different species, and on single species under a range of physiological and

environmental conditions. Normal population interactions and life cycles of species are a pre-requisite to under-standing additional impact stresses.

The whole ecosystem is vulnerable through food chains. Our knowledge of them is at least quantitatively rudimentary.

Spread of impact effects is enhanced by the eustuarine nature of the Beaufort Sea in which river water is spread over the underlying sea water in a rapidly changing pattern. There is a need for expanded base line data both in time and space, to give better knowledge of background physical factors which effect water movement at all depths.

Much more must be known about the sea ice flora, its conditions of life and its predators which forms the base of a far-reaching and therefore important ice-based food chain.

MR. BAYLY: Mr. Commissioner, would this be an appropriate time for coffee?

(QUALIFICATIONS AND EVIDENCE OF DR. J. A. PERCY MARDED AS EXHIBIT 446)

(QUALIFICATIONS AND EVIDENCE OF DR. E. H. GRAINGER MARKED EXHIBIT 447)

(EVIDENCE OF DR. J. A. PERCY, MARKED EXHIBIT 448)

(PROCEEDINGS ADJOURNED AT 11:30 A.M.)

(PROCEEDINGS RESUMED AT 11:50 A.M.)

MR. BAYLY: Mr. Commissioner, before we begin with Dr. Percy's second portion of evidence, there are two matters. At first, originally, Dr. Sterling was to be on this panel, and he arrives tomorrow, and if there are no objections tomorrow morning, if there are no objections from other participants or from you, sir, I would propose to add him on to the end of the table, and have him give his evidence in chief and be available for cross-examination with the others.

THE COMMISSIONER: Fine.

MR. BAYLY: I've asked Dr. Grainger if he could perhaps give an explanation of a couple of terms that he used, for the benefit of all.

Q Dr. Grainger, there were some terms used in your evidence in chief that perhaps you'd be good enough to explain. One of these is found on page 5, and it's "natural fixation rates."

WITNESS GRAINGER: Yes, that referred to the business of nitrogen fixation by bacteria, which is referred to on the same page, and identified as being the capacity of the bacteria to transform nitrogen into compound, usable compound.

Q And on page 6, there's a term, "bio-degradation potential".

A Yes. The reference there is to the potential capacity of bacteria to degrade oil, to break down oil, that is a biological break-down of oil.

THE COMMISSIONER: I assumed that's what it meant, and I assumed also that that was desirable, or have I got that the wrong way around?

A From the point of view of removing oil from the environment, yes sir, that would be desirable.

MR. BAYLY: The third term is on page 8, it's "pelagic fish".

A "Pelagic" refers to the, really though, to the water column which was mentioned by Dr. Percy earlier; the pelagic animals are those which occupy the space from the surface down to but not including the bottom, which either swim or float; and in the case of fishes it separates those which live on the bottom from those which swim about above the bottom.

MR. BAYLY: Mr. Commissioner, were there any other terms that you wished to explore?

THE COMMISSIONER: No, those in fact, were some that troubled me.

MR. BAYLY: We could go on then to the second portion of your evidence, Dr. Percy.

WITNESS PERCY: As I pointed out earlier, relatively little attention is being paid to the ecological effects of development on components of the marine eco-system, that while of little or no direct economic significance, nevertheless constitute the essential foundation of the ecological pyramid upon which these more visible elements are totally dependent for their very existence.

THE COMMISSIONER: Do you mean

we are -- by "we" I mean society -- we are worrying about the whales and the seals and so forth, and not about the elements of the lower end of the food chain?

A Right. The whole thing has to be considered in total rather than considering just the upper end of the scale.

In this paper, I'll primarily be concerned with the direct impact of crude oil upon marine invertebrates. An emphasis will be placed upon some of the sub-lethal effects, that although they are difficult to detect and interpret, are nevertheless, of greater ecological significance over the long term, than the more readily observable, rapid mortality of high oil concentrations.

As I mentioned earlier, the nature of the specific interaction of oil with the organisms is a very important consideration. Crude oil, unlike many other pollutants, by virtue of its relative insolubility , does not spread uniformly through the environment from its point of release. I'll primarily concentrate upon intertidal oil -- oil in the sub-ice zone, oil in the sediment, and oil dispersed in the water column.

The most dramatic and obvious biological damage associated with oil spills in temperate and tropical waters occurs when drifting slicks are driven ashore and blanket large areas of the biologically rich intertidal zone. In most areas of the western Arctic the intertidal zone is depressingly barren of marine life as a result of intense scouring

by sea ice. Therefore damage to invertebrate fauna in these areas will consequently be minimal. Such stranded oil is, however, still available for re-introduction into other areas of the marine environment, and should not be considered as completely inocuous.

THE COMMISSIONER: Excuse me, could I interrupt you. Maybe we're talking about two different things -- yes, we are, I'm sorry. When Dr. Gunn spoke about birds, he made the point that the area where the land meets the water is particularly important to them.

A Right. Yes, I should point out and emphasize that I am specifically referring in this paper to invertebrate fauna, and there will be cases where the effects on birds and on marine mammals will be quite significantly different.

THE COMMISSIONER: All right, I'm sorry.

A If the oil is released under ice, or transported there by currents, it will tend to accumulate in irregularities in the ice undersurface to form oil lenses of variable size. Accumulation of significant quantities of oil in under-ice habitat may have a number of very important ecological consequences.

As Dr. Grainger's pointed out, a rich algal bloom forms on and within the lower surface of the annual ice in the spring. This ice flora, and I'm quoting Max Dunbar here,

"forms an important faction of the total production

in the ArcticOcean and....it helps greatly to prolong the productive season beyond that of the water-borne phytoplankton"

In addition, a variety of marine invertebrates have been observed congregating in the general vicinity of the ice-water interface. This algal bloom may serve as an important food source for some species during the spring, a time when phytoplankton levels in the water column are rather low.

Although the algal components of such sub-ice communities have received considerable attention recently, little is known about the potential impact of crude oil on these phytoplankton. Virtually nothing is known about the general ecology and trophic inter-relationships of the animal components of this community and little is known about the sensitivity of the animals to crude oil. The impact of oil on organisms in the sub-ice habitat may, in some respect, be similar to the impact on intertidal fauna in other areas. In both situations animals are likely to be subjected to smothering and fouling by viscous oil masses.

A particularly disturbing aspect of the accumulation of oil in pockets under and within the sea ice, is that the trapped oil does not appear to weather significantly over the course of many months. The reason generally cited for the relatively limited impacts of crude oil spills in temperate and tropical waters is that the oil weathers very rapidly and loses

most of the toxic components while drifting as a slick upon the sea surface. This certainly appeared to be the case in the Torrey Canyon oil spill. Clearly this does not happen with ARctic under-ice oil spills. In the present study, the toxicity of oil recovered from the ice six months after being spilled was not significantly lower than that of fresh oil.

The recovered oil is, furthermore, virtually indistinguishable from fresh crude with regard to viscosity, density, gas chromatographic profile, and various other parameters.

This severe reduction in the rate of weathering of trapped oil has two potentially very important ecological consequences; firstly it provides a means of transporting the oil, in both a spatial and a temporal sense, without signifcant diminution of toxicity. Natural ice movements in the Beaufort Sea Gyre could result in the oil being transported considerable distances from the spill site and reintroduced into the water column, still in toxic form.

THE COMMISSIONER: Before we go on, just tell us what "BEaufort Sea Gyre" means?

A Yes, this is the general circulation of the ice and water in the Beaufort SEa itself. I think it's probably been discussed in Allan Miller's testimony earlier on, the sort of full implications of the Gyre.

THE COMMISSIONER: Yes, well that's later on.

A Oh later, I'm sorry, I was under the impression that he'd presented it already. I'm sorry; but it's the general pattern of circular movement of the ice in the Beaufort Sea.

In other words, there would be little decrease in toxicity with increasing distance from the spill site, as occurs in ice-free waters.

Perhaps of even greater significance is the fact that the oil from a prolonged late summer blow out would accumulate within and under the ice over a considerable period of time. There would be little or no diminution of toxicity with increasing time after release into the environment, as occurs in ice-free waters. Toxic components of the accumulating oil would be preserved unchanged until the spring break up, when some of the oil would be re-introduced into the water column en masse. In view of the initiation of intense biological acitivity in the upper layers of the water column during the post-break-up period, this may be the worst possible time of the year for the re-introduction of unweathered oil into the seawater. Planktonic larval stages of many species may be particularly vulnerable at this time of year.

The high sediment load carried by the Mackenzie River into the Beaufort Sea, in the form of a massive and visually impressive plume, poses special problems in terms of the consequences of a major oil spill in the area. The Santa Barbara blowout in California proved rather instructive in this respect. Heavy rains prior to this Santa Barbara spill resulted in a heavy

run-off that produced large sediment plumes in inshore areas. Oil slicks penetrated only short distances into such plumes, and much of the oil was absorbed on suspended particles and carried to the bottom. In effect, the sediment acted as a natural sinking agent.

At the first glance this might appear to be a rather effective self-purification process. In fact, it appears to compound the problem immeasurably. Unlike an oil slick, oil bound to bottom sediments is essentially beyond human control. Sinking does not remove the oil from the ecosystem, rather it concentrates it in one ecologically important part of the marine environment.

Little is known about the effects of such oil-contaminated sediments upon benthic epifauna and infauna; and I'm using the two terms here to differentiate between the animals that live above the bottom -- on the bottom but above it -- and animals that actually live within the bottom. So the epifauna is above, and infauna is actually within the bottom sediments.

The present studies indicate that certain benthic species are killed by short-term exposure to oiled sediments, but only at very high oil concentrations; concentrations that are unlikely to be realized in the natural environment, except perhaps in very close proximity to a spill. At present we have no information on possible toxic effects resulting from prolonged exposure to sediments tainted with lesser quantities of oil.

Of considerable ecological concern is the fact that certain species are capable of detecting low concentrat of oil in the sediment. Behavorial patterns may be markedly altered in the presence of such tainted sediments

Blumer suggested that the high lobster mortality associated with one oil spill may have resulted from attraction of animals to the spill site. Our studies indicate that different benthic species respond quite differently to the presence of contaminated sediments. The burrowing amphipod, and these are little shrimp-like animals, Onisimus affinis, exhibits a decide preference for untainted relative to tainted sediments. However , there are indications that at high oil levels the animals lose the ability to discriminate, possibly a consequence of chemical impairment of chemoreceptor function. On the other hand, another benthic amphipod burrows readily in both untainted and tainted sediments. Clearly behavioral responses such as these will play an important role in determing the overall impact of pollution upon particular species.

Once the oil is bound into the superficial bottom sediments, it is likely to have a long term effect on the benthic community. Studies in temperate areas suggest that oil trapped in sediments is degraded very slowly, and given the sub-zero temperatures of Arctic marine sediments, the rate of degradation may be even slower. The present study indicates furthermore, that the rate of decline in

toxicity of sediment-bound oil varies markedly with different oil types.

Oil contaminated bottom sediments may not be static. SEdiments in the Beaufort Sea are intermittently eroded and redeposited by bottom currents, so that the potential exists for contamination of a much wider areas of sea floor than that affected by the initial deposition. In the Santa Barbara oil spill, oil initially deposited in shallow water was later transported and redeposited in deeper areas. Oil may occur in the water column in both a dispersed and a dissolved state, and it is in these forms that it is likely to spread most widely through the ecosystem, and interact with the greatest number of species. It is generally agreed thatthe finely dispersed oil is more toxic to marine life than are soluble extract. This may, however, be largely due to the fact that much higher concentrations of oil occur in seawater, in a dispersed form rather than in a dissolved form. The droplets, once formed can be rapidly dispersed over a considerable distance and to great depths, as reported by Freegarde and Conover. Several days after the wreck of the tanker "Arrow", subsurface particulate oil was detected some 250 kilometres from the scene of the spill. Berridge and others point out that when oil is the continuous phase, there is no real limit to the extent to which the droplets are able to be dispersed.

Little useful information is available about the concentrations of oil to which Arctic midwater species might be exposed, and for what

length of time, both critical factors in assessing potential toxic effect.

In the case of a 65,000 barrel spill from a drilling rig in the Mississippi delta, the concentration of dispersed oil in the water column ranged from one to seventy parts per million within a one-mile radius of the spill.

On the basis of our short-term lethal studies most of the species that we have examined appeared to be relatively tolerant to high concentrations of dispersed crude oil. Even with what we've called sensitive species, dispersed oil concentrations of 100 parts per million or greater were required to cause significant mortality during four days continuous exposure. It is unlikely that such high concentrations will occur widely in the water column, but may be reached in limited areas in very close proximity to a spill, or where large accumulations of sub-ice oil are released into the seawater at break up.

It should also be kept in mind also in extrapolating lab results to a field situation that the experimental toxicity tests reported here were routinely carried out with fresh crude oil that was replaced at 24-hour intervals. Consequently, the experimental results are based on the worst possible exposure conditions that could conceivably occur. Exposure of the oil at the air-sea interface for any length of time would undoubtedly result in a gradual reduction of toxicity through weathering.

In view of the above

considerations it appears certain that massive short-term mortality among adult organisms inhabiting the water column, as a result of contact with particulate or sub-particulate crude oil, if it occurs at all, will be limited to relatively small areas. Furthermore, only particularly sensitive species are likely to be severely affected over the short-term, within these areas.

I'm just going to interpolate this following paragraph a little bit further down, so I'm going to skip the next paragraph and continue.

The short-term lethality studies tend to indicate a rather high tolerance level for crude oil among the various species examined. However, a closer examination of some of the more subtle sub-lethal effects upon physiological functions, suggests that the oil may not be quite as benign as it first appears. Such sublethal effects may directly result in the death of organisms over an extended period, or more insidiously may impair the animal's ability to withstand normal environmental stresses. Two measures of physiological function useful for investigating sublethal effects are respiratory metabolism and locomotory activity. Both may be severely impaired by exposure to low concentrations of dispersed oil. We are still not in a position, at the moment, to state with any degree of confidence, the actual long-term ecological consequences of such physiological changes, even though we do know that they occur. An exposure that rapidly kills the animal is clearly significant. It is considerably more difficult

to demonstrate unequivocally, that a 30% reduction in metabolic rate or a 50% reduction in activity has adverse, long-term effects on a population. The effects are subtle, and the ultimate consequences are very much influenced by a wide range of inadequately known factors.

Species differences were evident in the behavioral responses to the presence of crude oil As I mentioned earlier, certain species appeared to be totally indifferent to the presence of the oil and readily ingested oil-tainted food and burrowed in oil contaminated sediments.

In marked contrast, a number of other species exhibited a high degree of aversion to the oil; they tended to avoid oil masses, refused oil-contaminated food, and overwhelmingly selected and burrowed in clean in preference to oil-contaminated sediments. Studies suggest that the animals are capable of responding and detecting very low concentrations of sediment bound oil. These diverse behavioral responses may play an important role in determining the physiologically effective dose of oil to which the specific populations may be exposed. Furthermore, the pronounced disruption of feeding and burrowing behavior noted in some species could have far reaching implications reagarding the continued survival of these populations.

The use of physiological data, such as the above, acquired under carefully controlled lab conditions, to explain and anticipate biological events occurring in the real world, is a difficult enough exercise at the best of times. In the ARctic, the

process is rendered doubly difficult by the fact that our knowledge of conditions in the real world is deplorably inadequate. To be overly dogmatic under such circumstances is to be less than realistic. At best it is possible to hint at simplistic adverse effects on specific populations arising from direct encounter with the oil. We are on far less firm ground in attempting to assess the wider long-term ecological repercussion of these primary effects.

It is likely that given the right conditions, some reduction in the diversity of species in the area, as a result of the above lethal and sublethal effects, would occur. This may be a particularly important consideration in the Beaufort Sea and perhaps the Arctic in general. For as Grainger has just pointed out,

"the relatively simple population structure in the inshore water suggests a relatively uncomplicated food chain, and this means fewer but relatively more important links in the chain, and therefore greater vulnerability of the whole chain than one would expect in a more complex web."

At present, we know too little about Arctic marine food chains to be able to confidently pinpoint critical links that might be particularly subject to disruption by spilled oil. Intensive studies on the trophic inter-relationships of Arctic marine organisms are clearly required.

The potentially severe

biological effects outlined above, are likely to have relatively /limited ecological significance in the wake of a single oil spill during exploratory drilling, when considered on a broad geographic scale. Far greater impact can be anticipated from the cumulative effect of continuing minor and major spills during the production and transport of oil at multiple drilling sites. In the broader ecological context the critical point will be the relative balance between the accidental input of oil on the one hand and the rate at which the oil is removed from the environment by natural processes on the other hand. Indications are that in Arctic seas, the rate of input required to exceed the rate of natural removal, will be considerably lower than in temperate and tropical seas. In heavily exploited regions, the imbalance between the two could lead to oil concentrations over wide areas, approaching that at which sub-lethal physiological and behavioral effects are operative. Every effort should be made to obtain theoretical estimates of the magnitude of such of these factors, is input and elimination, under a variety of conditions.

Since the only means of rigorously testing such estimates is by monitoring an actual oil spill, a detailed program should be prepared now to intensively monitor the appropriate parameters in the event of an oil spill during proposed exploratory activites. Such information is essential for anticipating the potentially more serious ecological consequences of large scale production activitiy.

THE COMMISSIONER: Excuse me, Dr. Percy. Can we get our terms straight? By "spill", do you include a blowout?

A Yes.

Q You do? Well let me just ask you this. If you did, if you carry out exploratory drilling in the Beaufort SEa, you run the risk of a blowout, which, I take it, is what you've been dealing with principally, and of course you're concerned about the enhanced risk, at least I take it that's what you mean, if a large-scale program of exploration and production is embarked upon, consequent upon the building of a pipeline. We have heard that Foothills wants to bring a 35,000-ton tanker with fuel oil into Tuktoyaktuk Harbour, that's one of their proposals. So that is one aspect of this whole project that might give rise to a spill, and of course there is the liklihood of a minor spill of fuel oil in so many ways; handling, and so forth.

One thing you haven't mentioned is that if you had a program of -- if you were producing -- if you found oil and gas, well let's say oil, if you found oil in the Beaufort SEa and you were producing it, you'd have flow lines coming in under, it would be built under the sea bed, that seems to be the only way you could do it. Now, I have assumed all along that you were dealing with a blowout because that is uncontrolled, whereas a leak in a flowline presumably has only a limited potential for spillage because you can turn a valve at the wellhead and stop it, at least I

assume you can. At any rate, when you talk about a spill, you're really encompassing the whole range of possibilities.

A Right. I think it's generally true that, especially in temperate areas, the general feeling is that more oil gets into the environment through these various accidental small spil[ls] here and there, rather than by these massive spills that cause dramatic damage over relatively limited areas, but more massive damage, and this is what I was trying to get at. The long-term effects of these sort of cumulative spills are probably going to be more dramatic, or not more dramatic, but certainly more ecologicaly -- have a greater ecological impact over the long-term, over the broader area.

In addition, further studies of sublethal physiological and behavioral effects are required to determine the minimum concentrations of oil in the environment that are sufficient to induce significant sublethal disfunction in ecologically important species. Some of the behavioral effects that I've mentioned so far, in our study, we've indicated that they do occur, but we haven't yet pushed the concentrations of oil down to the minimal levels at which they occur, so we know nothing about this yet, and this is a fairly important point. The studies presented here are suggestive, but being of limited duration and scope must be considered little more than preliminary groundbreaking.

Short-term studies, no matter

how carefully executed, cannot be expected to adequately fill the void resulting from years of neglect of basic Arctic research., Arctic marine research in particular. It is unfortunate that the pace and scope of present attempts to fill this information void are more influenced by developmental and economic considerations, than by carefully considered scientific judgements.

THE COMMISSIONER: Excuse me doctor, for a second. When you say, when you refer to "Short-term studies, no matter how carefully executed", the short-term studies you're speaking of, are you referring to the Beaufort Sea study?

A Primarily, strictly impact studies of that type, yes, which are, you know, which are specifically oriented to a specific problem without having the broader background information on which to integrate the information from the short-term studies.

Q Could I ask you this? Dr. Grainger said that what is required is essentially purely scientific examination of the marine life of the Beaufort Sea, accumulation of a data base, and then he said a second way of examining this thing would be to have specific impact studies, I'm not doing justice to his dichotomy but, was the Beaufort Sea study essentially in the second category rather than in the first?

A In its principal aspects I would say, yes. Part of the problem is, as I pointed out earlier, is that it's fine to do a lot of these

lab oriented type studies, where you're looking at specific impacts on specific organisms; but then you've got to go to the natural environment, and unless you've got a good grasp of what's going on in the natural environment, no matter how carefully these direct impact studies have been done, you just can't fit them into natural environment, and you can't determine what the long-term effects are.

For example, we could show quite readily, for example, that a specific species is very sensitive to oil, and might be quite readily wiped out by an oil spill; but what impact that would have on the ecosystem as a whole, well I have no idea, because we don't know what animals depend on that species, what animals it feeds on, what it preys on this sort of thing. / We just don't know what all the inter-relationships are, sort of the basic structure of the ecosystem.

I've just indicated a few areas of further research here that might be contemplated. To attempt to outline important areas of additional study is a formidable task, particularly in view of the fact that little reliable information is available at present without even the most basic ecology and physiology of the great majority of Arctic marine invertebrate species. However, specifically with reference to direct effects of oil on marine ecosystems, the following work is particularly important.

In view of its obvious vulnerability to oil spills, we require further studies on the species composition, general ecology, trophic

inter-relationships, and ecological importance of this sub-ice community that Dr. Grainger and I have been referring to off and on.

Secondly, further studies on the interaction between spilled oil and suspended sediments to better understand the rates of incorporation, ecological impact, and the fate of crude oil in the bottom sediments. This is being done to a certain extent for temperate waters, but certainly nothing has been attempted in Arctic waters at the moment.

Thirdly, studies of lethal and sublethal effects of crude oils on major Arctic zooplankton species and particularly on larval stages, about which we know very little., as far as crude oil impacts are concerned.

Fourthly, further studies on sublethal physiological and behavioral effect to obtain realistic estimates of the minimum concentrations of crude oil, at which demonstrable disruption of physiological functioning occurs, particularly following extended exposure to the pollutant. Such estimates of biologically critical concentrations will be particularly useful in conjunction with item number 5.

And item number 5 includes studies on the time course of detoxification and the elimination of spilled oil from Arctic marine ecosystems in order to evaluate the relative balance between the potential rate of input and the capacity of the system to cleanse itself. This is, of course, particularly important in relation to item 4, where we can

demonstrate levels at which significant biological effects occur, but there is still not too much information about how readily these levels might build up in the Arctic marine ecosystem.

THE COMMISSIONER: Dr. Pimlott in his presentation referred to Alaska and, if I can find it, said that -- I probably can't find it -- but he referred to the work being done in Alaska and I -- it's in there somewhere, I'll find it after lunch -- but we share this Arctic Ocean with Russia , the United States and the Scandanavian countries, and Denmark, I guess, and I was wondering if any of you -- and you can comment on this after lunch at the appropriate time, or perhaps Dr. Millen could, Mr. Bayly. You people were carrying out this program, this 2-year program which had some deficiencies -- not deficiencies but inherent shortcomings -- and what about the Americans and Russians, have they carried out similar programs? Are they contemplating deep water drilling offshore? Are they concerned about the problems of oil spills in these northern waters? Have they been tackling similar problems, and if so, has it been done as you say, on the impetus being provided by developmental considerations rather than scientific considerations?

A Well, certainly there is a comparable program going on at present in Alaska, comparable to the Beaufort Sea program. It started as, I think, the Canadian Beaufort Sea program was winding down, and from the proposals and programs I've seen it seems to complement the Canadian Beaufort Sea progr

it covers certain areas that we have covered only in American waters, and it's basically a complementary program to the Beaufort Sea program and it is going on at present, and is being allowed to continue for, I think, about three years altogether.

The Russians have certainly had a considerable interest in the effects of oil on Arctic organisms. I can't speak too much as to exactly what the main regulating factors of this research have been but I know they have had fairly intensive research on the effects of oil on marine organisms in both temperate and Arctic waters.

THE COMMISSIONER: What time is it?

MR. GOUDGE: Would it be appropriate to break for lunch, sir? It's 12:30.

THE COMMISSIONER: We'll adjourn till two.

(PROCEEDINGS ADJOURNED AT 12:30 P.M.)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: Well, we will come to order ladies and gentlemen.

MR. BAYLY: Dr. Percy had a comment or two on the American program and he would like to deal with that now.

WITNESS PERCY: It has been brought to my attention that I said that the program was three years long, but in fact it is four to five years, the overall program there, now I'm embarking on slightly longer --

THE COMMISSIONER: Excuse me, the American program in the Beaufort Sea is four to five years long, and it is just now getting under way.

A It's not just the Beaufort Sea, in includes the Beaufort Sea, Chukchi Sea, the Bering Sea and the Gulf of Alaska.

Q Have they been engaged in exploratory drilling, exploratory wells, in the Beaufort SEa, either near the shore or in deep water?

A I couldn't really answer that, I don't think there have been any exploratory drilling off Prudhoe Bay, in the Beaufort Sea area.

A Perhaps then we could go to the evidence of Mr. Stein.

WITNESS STEIN: It should be apparent here, Mr. Commissioner, that the testimony that I am presenting, I have actually attempted here to take more or less a general look at industrial development activities in the delta region, in its

entirety, and I haven't restricted myself to strictly offshore explorations.

The Fisheries Marine Service, Western REgion, initiated studies of the Mackenzie Delta as part of the Environmental-Social Committee's Mackenzie Valley Pipeline Program. From a base camp located in Aklavik, between 1972 and 1974, field crews examined the fish resources over much of the southern reaches of the Delta, the main objectives being to:

One; define the biology and life histories of the major fish species including age composition, growth rates, species composition, distribution and food habits.

Two; determine the timing of fish migrations and the major migratory routes used.

Three; to locate and define critical habitat areas, including areas utilized for spawning, rearing, feeding and overwintering purposes.

Four; identify areas normally fished domestically and obtain an estimate of the quantities of fish taken.

The project results have been presented in a series of reports to the Environmental-Social Committee, and are listed as an appendix to this statement.

During 1974, a study of the anadromous and freshwater fish of the outer Mackenzie Delta was initiated under the auspices of the Beaufort Sea Project. In addition to expanding on the objectives

given previously, the Beaufort Sea Study also attempted to:

One; establish the seasonal and geographic sensitivity of the fish resources, and two; to examine lagoons subject to inundation from the Beaufort Sea, and ascertain their role in the life histories of major species.

A series of approximately 75 locations were sampled during the field season. Four of these were considered as monitoring sites and were sampled once a week. Results of the Beaufort Sea Study have been presented in two reports by Percy and others--Beaufort Sea Project B-2, and Percy Beaufort Sea Technical Report No. 8. Additional Fisheries projects conducted under the Beaufort Sea Program included studies of the Yukon coastal region by Kendel and others -- '76, Beaufort Sea Project Technical Report No. 6 -- and an investigation of the eastern Beaufort Sea by Galbraith and Hunter -- Beaufort SEa Project Technical Report No. 7.

Deltas in general represent some of the most productive ecological systems in the world. They represent important habitats wherever they occur, but are especially important in the north where alternative productive habitat often does not exist in the surrounding region. In the case of the Mackenzie Delta, many of the freshwater species of the southern Beaufort SEa and Mackenzie River system depend on the delta. Several marine species also frequent the outer delta.

Freshwater fish populations in the delta region can be placed in one of two rather general categories. This first of these, anadromous fish, includes such species as humpback and broad whitefish, Arctic and least cisco, inconnu and Arctic char, which spend much of their life cycles in brackish or marine waters while migrating into fresh water to spawn or over-winter. These spawning migrations may begin as early as July one -- I'm sorry, as late July, with the adults usually completing the return migration by November. While some species, such as inconnu and Arctic cisco, appear to migrate as far upstream as Norman Well, others, such as broad and humpback whitefish apparently utilize back eddies of the Mackenzie River, the delta itself, or more southerly tribuatires such as the Arctic Red and Peel Rivers.

The second category might be called resident species or populations which spend their entire life cycle in freshwater and are only rarely encountered in the marine environment. This group includes such species as northern pike, Arctic grayling, and suckers. Although migrations may be made, the spawning habitats are usually local.

Marine species, such as saffron cod, starry flounder and Arctic flounder normally reside in salt water. However they are frequently found in the brackish water of the inshore delta, presumably to feed. Additional species are also found farther offshore with ARctic cod being most abundant.

The delta region provides

essential habitat for a multitude of fish species. The Beaufort Sea study alone identified at least 19 species of freshwater fish and 4 marine species inhabiting the outer delta. Some species such as the Arctic cisco, feed heavily during the spring and early summer months prior to beginning spawning migrations. Once migration begins, it appears that feeding essentially ceases until the completion of spawning. Of course certain areas of the delta and Beaufort Sea seem to be more important than others for feeding purposes. This is especially true of coastal lagoons or lakes having outlets to delta channels or the sea. Clear deep lakes on the other hand are primarily used by lake trout and least cisco. Coastal lagoons also appear to be important nursery areas for anadromous species, the juveniles having moved down from spawning areas during the spring freshet.

Although spawning is known to occur within the delta itself, few specific areas have been identified. Resident populations probably make use of smaller lakes and channels or streams such as Holmes Creek. Populations of humpback and broad whitefish are thought to make use of backeddies within the delta, or the Mackenzie River itself. However, for most migratory populations the delta serves only as a migration route to upstream spawning areas.

Much of the delta and inshore Beaufort SEa also provide overwintering habitat for marine, resident and migratory populations. Lakes and channels with sufficient depth are utilized by whitefish, least cisco and lake trout. Least cisco, Arctic cisco,

Arcitc flounder, burbot, boreal smelt, inconnu and fourhorn sculpin overwinter in Mallik Bay. Areas suitable for overwintering are also plentiful along the northeast coast of Richards Island. Relatively small numbers of boreal smelt, humpback whitefish and least cisco have been netted through the ice in Kugmallit Bay, but this is probably a reflection of low fishing effort in winter. Inconnu and fourhorn sculpin have also been captured in the Shingle Point area, west of the delta, in winter.

Because of the abundant and diversified habitats available, the abundance of the fish resource itself and the use made of that resource, the Mackenzie Delta has been designated by Fisheries and Marine Service as an area likely to be sensitive to pipeline construction. There are several aspects of pipelining which are expected to adversely affect the aquatic resources. These include gravel removal, water use, increased sedimentation, road construction, increased fishing pressure and the use of methanol for pipeline testing. In previous testimony before this Commission, I discussed these concerns in some detail, and provided recommendations which, in my opinion, will reduce adverse effects to acceptable levels. These appear in Volume 103 of the Proceedings Pages 15720 to 15743. I only wish to point out here that these concerns and recommendations are equally applicable, if not more so, to the delta region as to the rest of the Mackenzie Valley.

However, there are other

development plans which could result in greater disruption to the resource than that associated with what might be called normal pipelining activities. Dredging for instance is proposed for the construction of major delta channel crossings and may also be required for development of medium draft harbour facilities for drill ships or to improve access to wharf and stockpile sites. Although such operations are normally of concern because of the environmental effects of increased levels of suspended sediment, they are of particular concern in an area inhabited by so many migratory fish populations. Dredging operations will likely be conducted during periods of mass fish migration but, in my opinion, we do not possess the predictive capability to speculate on how these migrations will react to multifold increases in normal suspended sediment levels, the mechanical noises of the dredging operation itself, or to changes in flow patterns either over the spoil pile or around berms constructed to facilitate dredging. These concerns could be mitigated by timing dredging operations to avoid critical migration periods. However care must also be taken to avoid interference with other resources such as the beluga whale.

Seismic exploration in the delta and Beaufort Sea region has increased sharply over the past few years and can be expected to continue for some time to come. Such techniques will be used to delineate gas and oil fields, determine the extent of permafrost layers and ascertain where abnormal

pressures may be encountered. Unfortunately, there is limited information available on how such techniques affect northern fish species. High explosives as well as air guns are currently in use, and while the former provides the best geological information, it is also the most destructive to the fish resource, including all the domestically and commercially important species. Mortality, especially, results with those species with gas bladders since they are unable to adjust to rapid pressure changes. Until better information is available, we can only recommend that seismic operations avoid known critical habitat areas and be conducted during times considered least sensitive to the resource.

The potential for disruption of aquatic environments can be expected to increase significantly during the exploratory drilling phase of delta development. One area of concern is the disposal of wastes and drilling fluids which are used in large quantities to equalize hydrostatic pressures, to remove drill cuttings and to lubricate the drill bit. They usually consist of a water-clay mixture, although many chemicals are added to the muds for viscosity improvement, pH adjustment, anti-corrosive properties, weight and a host of other desirable factors for drilling.

Drilling fluids from the Mackenzie Delta and nearshore Beaufort Sea have been shown in a number of studies to be acutely toxic to fish in freshwater, and more recently to both fish and

intertidal invertebrates in marine waters. In normal land-based drilling, drilling fluids, brines and cuttings, along with "house-keeping wastes", are contained for extended periods in earthen sumps and treated to render them innocuous. However, this procedure will not be feasible in offshore drilling where space will be a limiting factor. Since the composition of drilling fluids varies widely from well to well and within a single well, the toxicity to aquatic fauna is also quite variable. It is imperative therefore that there be stringent wast water and drilling fluid disposal regulations, and enforcement of those regulations.

The most obvious potential threat to the aquatic environment associated with proposed offshore exploration is a massive oil spill. Although fish gills are mucous coated, effectively repelling minute quantities of oil, they are incapable of accomodating a major polluting incident. If gills become oil-coated, respiration and ion exchange are severely limited. This ultimately leads to death since there is no self-cleaning mechanism. Fish are more likely to come into intimate contact with oil in a dispersed form, rather than floating slicks; moreover, oil in emulsion appears to adhere to gill tissue more readily. Solution of the lighter saturated and aromatic components of oil, also the most toxic to fish, in the water column occurs early in the life of an oil slick. An offshore spill would therefore tend to lose its toxic components before reaching the nearshore zone.

However, recent evidence suggests that oil can be incorporated into newly forming ice, thus rendering the weathering and biodegradation processes inoperative for extended periods; and I think reference was made on several occasions to this factor this morning.

Pollutants such as oil, also can cause nervous and gastric disorders in fish. Fish of different species, size and age vary in their resistance to pollutants. Physiological and behavioural changes brought about by pollutants will interfere with the ability of fish to cope with the "normal" stresses in an already harsh environment. There is a definite need to examine the sublethal effects of pollutants on aquatic organisms. The presence of even small quantities of petroleum hydrocarbons, in the flesh of fish can also produce disagreeable flavour and odours. This is an important aspect considering the domestic utilization of the resource in the southern Beaufort Sea.

Most likely however, impact on the fish resource itself resulting from an oil spill will be through large-scale loss of food organisms, probably resulting either from a change of food habits, or in a change in food habits, or emigration from the contaminated area. Sinking readily takes place --

THE COMMISSIONER: Excuse me, Mr. Stein. What is it that you want to say there, "probably resulting either from a change in food habits"?

A I think that was possibly a typing error, sir. I believe it should read that probably resulting either in a change in food habits of

the fish themselves, or else emigration from the contaminated area.

Sinking readily takes place in estuarine loations since suspended sediments are available as adsorptive nuclei for oil. The benthic flora and fauna upon which many fish species depend, may, as a result, be reduced or contaminated for extended periods. Free oil and emulsions can also coat algae and other plankton, causing them to settle to the bottom, out of reach of pelagic fishes.

Any large scale reduction in the aquatic invertebrate fauna would have a profound effect on the fishery. Stomach analysis indicate that fish utilizing the area are largely dependent on this fish resource, on this food resource, sorry. Many of the fish species present tend to be opportunists in their feeding habits and could therefore probably compensate for minor changes. It should be noted that all species are important to the stability of an ecosystem, since the more diverse the biological community, the greater its ability to compensate for changes in the environment.

SEveral coastal areas near the Mackenzie Delta contain fish populations which may be sensitive to contaminants originating offshore. It appears that many of these lagoons and embayments are not normally flushed by the Mackenzie. Low rates of exchange of water and the occurrence of storm tides therefore render these areas highly susceptible to pollutant contamination from routine exploration activities or to oil from an uncontrolled well blowout.

Areas sensitive to disruption are found along the west coast of Tuktoyaktuk Peninsula, the irregular coast, I'm sorry, northeast shoreline of Richards Island between Pullen and Hendrickson Islands, the Mallik Bay area on the north shore, and the Yukon coast. All contain large populations of adults and fry throughout the summer months, primarily whitefish, ciscos and inconnu. These habitats provide a haven within the Beaufort Sea/delta area for marine species such as flounders, sculpins, pacific herring and saffron cod. Fish also concentrate near Kendall Island, least cisco and burbot; and Garry Island, boreal smelt and ciscos, during the summer. These areas become even more sensitive in fall, at which time inconnu congregate for overwintering in nearby channels and in Mallik Bay. With the exception of the western and northwestern portion of Shallow Bay; which is a migration corridor for char, inconnu and ciscos, no large fish populations were found in the region between Shallow Bay and Garry Island during our Beaufort Sea investigations.

Should a massive polluting event occur offshore of the delta, it is imperative that the polluting material be prevented from reaching critical inshore habitats. In my opinion, mechanical clean-up techniques alone should be used in combating oil spills until we have gained a greater insight into the fate and effects of dispersants and of dispersed oil in the marine environment. Often, the emulsifiers that are used in temperate waters prove to be more toxic to fish than the oil being mopped up. Similarly, sinking

agents merely transfer the problem from the surface to the bottom where it becomes virtually impossible to deal with. Mechanical clean-up equipment now in use must be radically improved to cope with oil spills at sea and new approaches devised to recover oil on and under ice. It is recommended that during any polluting incident first priority be given to preventing oil or other pollutants from moving into the nearshore zone where contact with estuarine waters will lead to its sedimentation and retention for extended periods of time. Sedimentation of oils and tars along the coast could destroy nursery and spawning areas and may kill essential benthic food organisms or force them to emigrate from the area.

If approval is granted for offshore exploration, an essential requirement is a program of effective resource monitoring studies that will facilitate the identification and resolution of potentially dangerous environmental problems at the earliest possible stage. Studies done to date are not adequate to predict the effects of extensive offshore drilling and production in the Beaufort Sea. It is important that further studies be carried out prior to such development, during the period of disturbance and during an assessment phase. It is critical to monitor control zones, along-side impacted areas, in order to distinguish natural evironmental trends from those changes induced by man. Now that an inventory of base-line data for environmental components in the Beaufort Sea has been compiled, adequate oil clean-up contingency

plans can and must be developed. These must not be imported from other less hazardous areas in the south, but be developed with the specific environmental problems of the area as a focus.

It is my understanding that baseline hydrocarbon levels in tissues of a few species of plankton, invertebrates and fish, as well as for Beaufort Sea water have been determined. The report is not yet available. This program should be expanded to provide reference material for comparison with hydrocarbons found in tissues and water at later dates. This will be particularly useful in determining the persistence of oil in the Arctic aquatic environments. Industry should provide samples of oil discovered in the Beaufort Sea area to allow meaningful site-specific toxicity and behavioral studies to be carried out.

In conclusion, the Mackenzie River Delta provides essential habitat for the maintenance of the freshwater, coastal marine and anadromous fish resources in much of the southern Beaufort Sea area and Lower Mackenzie River. The inshore zone is an important nursery, feeding and overwintering site for both nearshore and offshore organisms. It is especially important to those anadromous species which form the basis of the domestic and commercial fishery in the Delta, that is broad whitefish, Arctic char, Arcti cisco, and inconnu. Standing stocks of fish are greatest nearshore since the anadromous species tend to frequent shallow coastal waters during the summer months rather than moving far offshore.

Proposed developments in the delta region can be expected to adversely affect aquatic resources. In my opinion, only if industrial developments incorporate environmental design measures, as recommended to this Commission, will these effects be minimized.

THE COMMISSIONER: One question Mr. Stein. On page 10, you say about seven lines down,

> "Now that an inventory of baseline data for environmental components in the Beaufort Sea has been compiled, adequate oil clean-up contingency plans can and must be developed."

The impression I got from Dr. Grainger and Dr. Percy was that, that wasn't something that they could say about the fields of their expertise. Limiting yourself to these fish species, well let me put it this way, are you limiting yourself to these fish species, or am I to take a larger meaning from what you've said there?

A I would say that primarily I would limit myself to fish, but I think that what I was really getting at was, I think if we were to take a poll of the panel sitting here, I'm sure that we would all agree that we do not have as much information as we would like, but the -- as I see it right now, we have at least a preliminary feeling for what is there, where they are, what the abundance of the fish species is.

Q What you're saying is that you know enough to decide that your first priority would be, if there were an oil spill in the Beaufort Sea, to keep the oil by any means away from the inshore area.

A That's correct. I think that we've got enough now, and looking towards the future and the likelihood of increasing our knowledge, I think that it's imperative that we start planning on the basis of what we have, at least, and modify accordingly.

THE COMMISSIONER: Thank you.

MR. BAYLY: I wonder if we could go now to Dr. Barry's evidence, and Dr. Barry could you read your evidence before the Inquiry?

WITNESS BARRY: Yes. First I must apologize for the condition of this report. It is typed from a garbled tape and I didn't discover it until just the other day, and make any corrections, so I'll attempt to paraphrase in spots.

Birds found in the Beaufort Sea region converge from wintering grounds in the Pacific and Antarctic Oceans and from North and South America. That is about a third of the surface of the globe. Of the birds nesting on the Coast of the Beaufort Sea and the Arctic Islands, approximately two-thirds migrate through the Great Plains and the Mackenzie Valley, while the rest travel through the Bering Straits and follow the coast of Alaska, Yukon, and the Northwest Territories.

Water birds moving along the narrow leads, which usually form between the shore-fast ice and the Arctic pack in May and June, can become extremely concentrated under certain conditions. Species using the Arctic coast migration route include Arctic terns, Sabines gulls, jaegers, all coming from the

Antarctic and South Pacific. Pacific brant from coastal Mexico and California, and murres and eiders and glaucous gulls from the North Pacific and Bering Sea. Some species flying the interior migration routes also use the coast, especially the whistling swans, which move westward in the spring from the Mackenzie Delta and travel along the Yukon and Alaskan coasts. Many of the snow geese follow the coast of the Tuktoyaktuk Peninsula while enroute from the Mackenzie Delta to Banks Island and they also use these same routes again in the fall, there's almost a duplication.

The Beaufort Sea is very shallow near the coast. The ten-fathom contour line is about 20 to 25 miles offshore. Tidal changes are only between one and two feet, but onshore winds can often cause storm tides of up to eight feet during the ice-free periods. The polar pack ice may completely cover the Beaufort Sea in any season. Typically, however, an ice-free margin extending from three to one hundred or more miles offshore exists at least intermittently between early July and late September.

The discoveries of oil and gas along the rim of the Beaufort Sea and the prospective offshore drilling has shown the need for more reliable information about the marine avifauna. In the past, population estimates of Beaufort Sea birds were from casual surveys conducted as part of other studies or reconnaissances. From work done in the past several years, we estimate that there are

approximately 2,000,000 migratory birds that frequent the Beaufort Sea and the littoral zone; by the littoral zone, I mean the area up to the highest of storm tides. There are several species of water birds, for which the shores and marshes are the principal nesting grounds. For large numbers of seabirds, the coastal bays, the lagoons, the barrier beaches and the islands are important as nesting and for molting. For seabirds migrating along the coast, the open water leads in the sea ice are the traditional places for resting and feeding. Open water leads form along the Coast and allow a migration route, which the birds follow, and it's become quite traditional, it occurs almost every year. To reduce the risk of contaminating these birds by an oil spill or a blowout, it is important to know the critical times and places for the birds found in the Beaufort Sea. Such information about the avifauna makes possible the timing and location of drilling and support activities in order to minimize the danger.

The data presented here concerning the spatial and temporal distribution of birds in the Beaufort Sea results from three different methods of doing surveys: regular ground surveys where you sit and watch them migrate over us, aerial surveys, and more recently, radar observations. However, it is difficult to estimate the numbers of migratory birds because of difficulties of weather conditions, difficulties of visibility and because it's an ever-changing, mobile population. Nevertheless, it might be useful to make a few estimates of some of the more

important birds. There are at least three species of loons that are normally seen in the Beaufort Sea, and our estimate is that approximately 35,000 of these birds will pass through the Beaufort Sea at any one season. There are three different species of jaegers that migrate through the Beaufort Sea. Our estimate is 21,000. The largest gull in the area, the glaucous gull, we estimate at about 35,000. The old squaw duck, or squaw duck, is a very common bird in the Arctic, and approximately 1,130,000 are estimated to migrate through the Beaufort Sea. There are two species of eider ducks, which we lump together for some reasons of difficulty of identification, and we estimate at about 1,100,000 are found in the Beaufort Sea area. Whitefronted goose, whitefronted geese use mostly the coastal areas on the mainland, approximately 25,000 are estimated to occur in the Liverpool Bay area, and includes Eskimo Lakes. There are at least 200,000 snowgeese nesting on Banks Island and many of them follow the shores at Tuk Peninsula enroute to Banks Island. There are approximately 25,000 to 30,000 Pacific brant migrating along the coasts of the Beaufort Sea, also there are uncounted thousands of shore birds: plovers, turnstones, sandpipers, and so forth.

I will digress a bit here to mention the radar studies that we had conducted last May and June from Komakuk Beach near the Alaska border. We found that above the normal range of visibility, there were birds migrating through at elevations up as high, in some instances as high as 16,000 feet. Where their

destinations were, and exactly how many were involved, is very difficult to see, because all we're getting were radar blips of birds coming over the mountains and from several different directions. Their total number and their destination we don't know, but this would be added to these estimates that we're making.

During our ground, aerial and radar surveys conducted in the years 1972 through 1975, we covered the coastal lagoons and the shorelines, and as far out to sea as 200 miles; in other words the southern part of the Beaufort Sea. This coverage to 200 miles offshore, covers approximately the same area the Federal Oil leases for exploration and development of oil have been made. It's a bit astounding that there are oil leases quite far out to sea.

As a result of all these surveys, we found that as far as birdlife was concerned, that there are sensitive areas and times for their occurrence in the Beaufort Sea. The most important are the ice leads, those areas of open water that form between the shorefast ice and the Arctic pack in the early spring. The leads are a migration route for some species like eider ducks, old squaws, and loons, where they have a place to stop either to rest or to feed during their migrations. During the fall migration, the ice has usually retreated to the north. There are large areas of open water. The ice leads are important only during the spring migration which occurs around the first of May to early June. Some migration actually begins in April.

The aspect that makes the ice lead so sensitive is the fact that a sea bird may be flying for literally hundreds or even thousands of miles over ice before it finds anything that even looks like water. There are traditional places such as off Cape Dalhousie, and earlier off Cape Perry, where almost invariably be open water in early spring. These birds will concentrate there because it is the only place where they can land, they have to land on water. Some species, like loons, are incapable of taking off from land, so they're absolutely helpless unless they can land on water.

We have found in our flights that as many as 75,000 to 100,000 eider ducks and other diving ducks can be concentrated at these spots, like off Cape Dalhousie, at any one time. This is a transient population, that might be there one day and could replaced by another large group the next day or week, as the birds continue moving along to their nesting grounds. The attractiveness of the first open water to appear in the spring can be demonstrated by a photograph which I'll pass around. This photograph was taken about twenty years ago, in 1957 or 1958 by a bush pilot at Norman Wells. There was an oil spill on top of the ice early in that year. It looked like water, and the first arriving ducks and geese therefore found it as the place to land. The attractiveness of openwater to first-arriving birds is true, not only along the coast, but also along the Mackenzie River in the pre-breakup stage. You will note that this picture

and it looks like water, is nothing but a large pool of oil. In the course of a few days over 400 migrati geese, swans and ducks were trapped. The second photograph shows the condition of these birds. They were of course completely wiped out. So this is one sensitive and important area: the first-appearing open water in the spring, in this case the leads along the Arctic Coast.

The other sensitive areas for migratory birds in the Beaufort Sea are the coastal lagoons, and bays and barrier beaches and the tidal marshes from June through late September, and even actually into October and to freezeup. The barrier beaches and the coastal areas and the tidal marshes are important for several reasons. It is the rearing area for birds that nest either on the marshes or on the periphery of these areas. THe young are frequently taken to the water where they feed and develop. It is also a moulting ground -- all ducks, geese and swans, by the way, moult in the summertime, and by that they lose all their flight feathers and become completely helpless.

For protection, large flocks get into the bays and lagoons and become flightless for a period of 30 to 45 days, depending on the species. These birds are absolutely helpless. They are unable to fly and any oil spill or contamination of these barrier beaches or the lagoons will result in the destruction of whole flocks. They flock up together for protection, so they're usually quite concentrated.

Later on in the fall, from August through September, the coastal marshes and the barrier beaches are staging areas. For instance, snow geese from Banks Island will migrate to the mainland coast, where the season is a bit more delayed, and they are able to feed and gain body weight and strength of flight, or strength in wing for the long migration south. These fall staging areas, especially the outer part of the Mackenzie Delta, and along the north coast of the Yukon and the Tuk Peninsula, are important to snow geese, whitefronted geese, brant, and many ducks.

There are about 100 different species of birds which use the Beaufort Sea or its littoral zone, sometime during any particular season. It is impossible to generalize about any one of them and their propensity for being involved in an oil spill, or a coastal pollution. It would be confusing to try to go through the life histories of all these different species. I think the best way would be to take several representative species of some of the more economically important and trace their occurrences in the Beaufort Sea at any particular season; and try to pinpoint areas that are liable to be critical, should an oil spill occur.

Probably the most valuable species in the Mackenzie Delta and the Beaufort Sea region is the lesser snow goose. Snow geese arrive in the spring by way of the Mackenzie Valley, stopping at various places, especially along the river where the first open water occurs. I mentioned earlier - the photograph at Norman Wells.

This is one of the areas where if there appears to be open water, the geese will stop. They move north through the latter part of May and to the outer part of the Mackenzie Delta. Many follow the main channel of the Mackenzie, and then to Kitigazuit and along the Tuk Peninsula to Banks Island.

In this area snow geese are an important species, a food source, for the residents of Tuktoyaktuk. They arrive at Banks Island in the latter part of May, and begin nesting by the first of June. Approximately 200,000 snow geese nest on Banks Island. The nesting grounds are inland from the coast, and Banks Island is what we call the main colony, and there are two satelite colonies, or subcolonies: one of them is at the Anderson River Delta, and the other is the Kendall Island area in the central part of the Mackenzie Delta. Both of these areas are low and are subjected to spring floods and in the fall are subjected to storm tides. The storm tides in the fall could carry oil well onto the flats. As we mentioned before, storm tides of six to eight feet can occur, depending on how strong the wind is.

After the young hatch, the snowgeese, they disburse on foot and moult on the various river islands of both the Anderson River, the Kendall Island area, and on Banks Island. When the young are approximately four weeks old, and are able to fly, they begin to accumulate into flocks ready for migration to the staging areas. The fall staging areas for snowgeese are the Mackenzie Delta westward into

Alaska, and in some years on Bathurst Peninsula. Geese are grazing birds, feeding to a large extent on the grasses and sedges of the low flats of the Mackenzie Delta, although they also go upland into the slopes of the Yukon and Alaska. This particular area in the fall is very sensitive. A storm tide could carry any large spill onto the land. If the geese are disturbed or if their food supply is destroyed by residue of oil entrapped on the flats, it would just about eliminate their ability to gain enough weight to continue their migration. When the snow geese leave this area, they have to put on, usually gain about one pound in the course of twenty to thirty days, in the outer part of the Mackenzie Delta, and if they are in good physical shape, they are able to overfly the taiga, all the way into the northern parts of Alberta, or in central parts of the prairie, which is their next source of food. Very rarely do they stop along the Mackenzie River, or on the lakes on the way south.

Other species representative of the Beaufort Sea are the eiders, both the king and the common. They winter in the Bering Sea in the North Pacific and in early spring, especially the males first, follow the ice leads around the coast of Alaska and along through the Beaufort Sea to nesting grounds, located in the Arctic Islands and along the coast as far east as Queen Maud Gulf. The migration route is a traditional one that follows the open leads that are expected to be found along the coast.

These leads are present more

years than they are not; but on occasion, as in 1964, strong onshore winds prevented the leads from opening up. We found eider ducks scattered along the coast all the way from Prince Patrick Island, Holman Island, Sachs Harbour, the complete Tuktoyaktuk Peninsula, all the way to Point Barrow in Alaska. This was an unusual situation in which no open water was available until the end of June, after migration was over. In 1964, we estimated approximatly 100,000 eider ducks died of starvation as a result of the fact that the leads did not open up.

Now, it might be safe to assume that if the leads were open, or if there was anything in the leads that looked like open water, the eiders would land in it. In fact there was a small piece of open water in the fingers of the Eskimo Lakes, near Saunatuk, which is not on the normal migration route, but in that particular year it was covered with eider ducks , there were 10,000 to 15,000 birds jammed in one small piece of open water. Now, let's assume that an oil spill had occurred on the ice, and it would look to an eider duck, just like open water, the only open water for hundreds of miles. You can be sure that because the offshore drilling locations are practically on the fringes of the migration route, that literally thousands of birds would come into that "open water" as a spot to feed and rest. This is an exceptionally sensitive area. It would affect not only the eider ducks, but also old squaws, loons, and quite a few other species.

The critical period for eiders would be from about the 25th of April when the males first arrive, until the end of the migration to the eastward, which terminates around the latter part of June. But in the case of the eider duck, that's not the end of it. The male eiders, just as soon as the female has started nesting, migrate back west again to the northern Chucksi Sea, and by early July, that migration is well under way, and is a continual migration back westward for their annual moult. Throughout the season there is continual migration of eiders, either east or west, right up until freezeup. In fact, we've seen eider ducks flying past Johnson Point on Banks Island as late as the 25th of October, even though it was twenty below zero. There was enough open water for them to find places to stop.

Eider ducks feed primarily on the bottom of the ocean. They dive to a considerable depth, and is probably why the shallower open water found off Cape Dalhousie is one of the main concentration points for eiders. We are not very sure of their food habits at this time, although they are known to take clams and probably marine isopods, and other things of that sort. What an undersea contamination might do to the food chain of this particular species, we are not aware of at this time. Other speakers have mentioned some of the bottom problems.

Another area and species to consider as a typical sea bird, namely the murres. The murres nest on cliffs in very large colonies. In the Beaufort Sea area, there is only one colony of murres

and it is relatively small. It is located at the very tip of Cape Parry, near the Parry DEW Line site. It happens to be a migratory bird sanctuary, at the time. It is a small cliff with the necessary combination of an early opening in the water in the areas around the bottom of the cliff. The murre is entirely a marine feeder and the colony at Cape Parry is unique in that there is no other murre colonies for a thousand miles to the east, north of Summerset Island; or to the westward, the nearest murre colony is approximately 1,500 miles away in the north end of the Bering Sea. We have a unique group of birds that are completely controlled by the sea. They feed on the open waters. In fact, we're not even sure their taxonomy is; we assume they are related to the Pacific birds rather than to the Atlantic birds. Their food habits are largely unknown although murres normally feed on small capelin and other small marine fishes. The murres also use the ice leads stopping points in their migration, and of course need the open water near the base of the nesting cliffs.

THere is in the literature, considerable amount of studies reported on the cleanup of seabirds, once they have become oiled. Oil matts the feathers of the birds and destroys the down insulation, and it also destroys their buoyancy. You'll notice in that picture that the ducks that are in that puddle of oil, are very low in the water. The bird is immediately subjected to the cold waters, and dies of hypothermia. It is possible to remove oil with

detergents, but in every case, although the bird may survive briefly after it has been cleaned up, they invariably die. Even in warmer climates, such as at the Santa Barbara oilspill in California, attempts to clean birds and rehabilitate them turned out to be unsuccessful. Some birds were returned to the water, but a close follow-up found that virtually all of them died within a week or two after they had gone through the cleaning process.

In the Arctic, with its difficult logistics and perhaps bad ice conditions, when one would expect to have trouble with oil spills, I am extremely pessimistic about any attempts to salvage or rehabilitate any bird that got into an oil spill. With the continual turnover of birds in the migration period, one could expect very high mortalities, as long as the spill lasts. How quickly a spill could be cleaned up is something that I do not know; and I don't think the proponents have been able to come up with a satisfactory answer on how quickly oil could be cleaned up or disbursed.

Along the coastal lagoons of the shores of Beaufort Sea, a group of waterfowl, scoters, they're locally called black ducks; scaup and old squaws gather to moult. They arrive in the coastal lagoons in the middle of July, the males come to these areas from inland nesting grounds. THey are joined by old squaw ducks, both breeders and non-breeders; primarily male birds and younger females that don't nest until they are two years old. They are

flightless for a period from the 15th of July until almost the end of August. Around the Tuk Peninsula approximately 600,000 of these ducks are flightless along the various lagoons and barrier beaches. The Tuk Peninsula is not used for moulting in every year. In some years there are very large numbers occurring in Northern Alaska. They are completely helpless during this flightless period. Their only means of escape is to dive and swim from one spot to another. They feed on the various marine fishes and marine invertebrates that are found in the protection of the barrier beaches and the lagoons. Any oil spill that has washed ashore or over the barrier beaches and into the lagoons, would cause very serious damage to this particular population of waterfowl.

In the plans for offshore drilling, the two sites that Dome Petroleum has in mind, at the outset, are located near the edge of the shear zone. By the shear zone, that's the boundary between the land-fast ice and the drifting pack ice. This is on the migration route. The logistics of getting to an oil spill when there is moving ice, and how they will drill a relief hole if there were a blowout, are all contained in the scenarios of what would happen should a blowout occur. I understand, these will be presented at this Inquiry by other people who are more familiar with the ice movements and the currents along the coast. Needless to say, one can expect birds to be found any place with open water during the period from the first of May approximately until the end of October. I am not too encouraged by the so-called

contingency plans. I had opportunity to see the Dome Petroleum ones. How could they possibly prevent oil from occurring in many areas as the currents move along the coast of the Beaufort Sea? I will not try to reconstruct the scenario of an oil spill. I understand Mr. Millen, Dr. Millen is going to be doing that. In any event, it makes rather grim reading. I am sure it will be presented at this Inquiry another time. The only thing that probably can be done is to pinpoint the place and time where most birds can be expected to occur and thus try to avoid drilling and construction activities at these times and places.

It is a difficult thing to do because no two years are the same. 1974, the year of the so-called Beaufort Sea Studies, was one of the poorest ice years on record. The only two years I know of from my experience that were worse was the year 1959, and the year 1964. A year like 1973, which was a very light-ice year, would create a whole different distribution pattern of water fowl, and a whole different set of logistical problems for the drillers and the construction people. I find it difficult to try to predict an impact of something that we have little control over, namely, the weather and the ice. The whole question of environmental impact and environmental impact assessment, and environmental monitoring, disturbs me considerably. I find it difficult to see how an unknown situation can be predicted. An environmental impact is what people are trying to predict might happen in the future, and hence devise ways to alleviate it.

I think to monitor an environmental problem is not going to really cure anything. It is just documenting for historical purposes what has actually happened , and after the fact. It is, in the area of the Beaufort Sea, to me, it is complete speculation of what might happen and how things might occur.

The knowledge of wave action and ice action has been determined on the basis of very limited years of experience and I think it would be extremely difficult to make any prediction as to what might occur, and from there to try to predict an impact of what would result. If there is a time when there are big waves, that's storm tides and things like that, and there happens to be a blowout, which direction would the oil spread? There are guesses at some of the -- in some of the oil spill scenarios. To me an impact statement should be related to some historical events, if possible. There are many historical events to which analogies can be drawn, at least on the land operation part of the pipeline. I shall now consider the cross-Delta route and the route along the North Slope , on which I think some remarks should be made, although briefly, at this time.

As I mentioned before, the low flat islands of the Mackenzie Delta, are subjected to storm tides and possible deposition of oil or any other contaminants over large areas, which in turn would probably affect the plant life of the Delta. The Delta is important for snow geese nesting in the

Kendall Island Bird Sanctuary. It is also an important area for whistling swans; probably one of the most dense nesting areas in North America. There are parts of the Delta which are extremely important to white-fronted geese, many varieties of ducks, such as pintails, mallards, scuap ducks, old squaws, and so forth. There are also sandhill cranes and shore birds nesting in the Delta. The Mackenzie Delta lowlands, and I include the area from Richards Isalnd to Blow River, as an important fall staging area, for geese coming into the Delta. It is one of their first stopping points before they disburse along the coast and the North Slope. It is one of the last places that receives snow cover in the fall. It is a point of departure southward in the fall for many of these birds. In a good year, after Banks Island or Anderson River, or Kendall Island, has had high reproduction; all the snow geese arrive into the Mackenzie Delta's outer islands, with many young with them. Their population could jump as high as 400 to 500,000 birds. The impact of the pipeline through the outer delta's prime nesting and staging area is going to be difficult.

There are some historical impacts --

THE COMMISSIONER: Maybe we could stop for coffee now. I've found your presentation helpful, but it's densely packed and maybe we could stop for a few minutes, and then we could resume.

(PRODCEEDINGS ADJOURNED AT 3 P.M.)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: We'll come to order again.

MR GOUDGE: I suggested to Mr. Bayly, Mr. Commissioner that in the interest of continuity it would help me at least if we backed Dr. Barry up to where he began talking about the cross Delta which was I think just a paragraph or so before we broke.

THE COMMISSIONER: The middle of page 14. Maybe you'd start again the middle of page 14, Dr. Barry , to preserve our continuity of thought about the North Slope and the cross Delta.

WITNESS BARRY: The middle of page 14 or page -- A lot of philosophizing about environmental impacts and I -- trying to develop the pure speculation that seems to, in my mind has involved with the some of the work in the Beaufort Sea where we're trying to predict ice and weather and their effects and as far as in the Delta is concerned it's possible to take advantage of some of the historical impacts that we can-- so we can draw analogies from that , and I've -- up through to the middle of page is we developed that there can be up to 500,000 snow geese appearing in the Delta at the outer part of the Mackenzie Delta . There are some historical impacts that we should try-- from which we should try to draw analogies. I think it's probably safer to do than to speculate on what might happen as in the Beaufort Sea

problem itself. Proponents state that pumping stations along the pipeline route will be spaced fifty miles apart with an airstrip at each one. Some years ago, beginning around 1955, the Distant Early Warning or Dew Line sites were constructed coincidentally every fifty mile along the coast, and built at a time when there was little or no concern for environmental damage. The Dew Line sites were built with tremendous aircraft, land and sea support. The construction of the Dew Line sites involved aircraft in numbers larger than the famous Berlin Airlift. There's a lot of similarity between Dew Line sites and what the proponents say a pumping station will be. I can not for the life of me figure out why they have not done historical studies on what impact the Dew Line sites had on the flora and fauna along the route. Furthermore I find it quite difficult to understand why the Dew Line sites are not themselves used. Why not a site that has already disturbed the countryside? The way the route is planned, at least along the North Slope, which is also a very critical area, as brought out in the hearings in Yellowknife; it is doubling the amount of disturbance of the environment, at least as far as the pumping stations are concerned. The proponents should demonstrate why existing Dew Line sites could not also be used. Dew Line sites are recognized to be obsolete, so why shouldn't the line be constructed to connect between the various sites and make use of them. In crossing the delta the proponents have chosen some of the prime and best waterfowl habitats. The proposed line crosses Moose Channel

Flats and in the area of Coal Mine Lake and Moose Channel itself, and crosses Shallow Bay to Ellice Island area which is one of the most concentrated areas for staging geese and also very important for nesting swans, cranes and ducks. In the middle of that area another compressor station is planned. I cannot see why they don't put a compressor station back on the mainland near Shingle Point, where there is already a Dew Line station. Tununik, which is the next Dew Line station to the east is approximately fifty miles from Shingle Point. Why do they have to end up with a compressor station in the middle of the Delta, and with some of the most sensitive areas I know of ?

Some years ago I participated in a study that was done for the Arctic Petroleum Producers' Association and financed, at least in part by Imperial Oil, and the Government of Canada or the Canadian Wildlife Service, on the effects of oilwell drilling on wildlife. This was done at the original Taglu discovery site located at the boundary of the Kendall Island Bird Sanctuary.In that study we found noise levels of over 100 decibals. There were frequent helicopter arrival and departures, although I must stress that Imperial Oil followed a prescribed helicopter route to and from the site, because of its environmental sensitivity. The site appeared to have as much activity around it as a compressor station in its construction and operational phase. We had plots for studying nesting densities of birds around that site. Plots were in a 1 ½ mile radius around Taglu. We had a control area

behind some hills over by Swan Channel and Richards Island, which was of similar terrain. We found that as far as nesting birds were concerned, approximately 50 percent of them were disturbed enough to have moved out of the area. There were another 50% that seemed to be undisturbed. Then there were some that had nested in traditional nesting sites, for instance swans and geese do that, and they had been nesting there for many generations before the drill rigs suddenly appeared in the spring when they got back from their migrations in the winter. One such swan nest was a quarter of a mile from the rig, but as soon as the young had hatched they took the young considerable distance from the area. In other words they were sort of tied to this traditional nest site but as soon as they became mobile again with the young they moved out of the area. Coincidently I had worked in that area for about three or four seasons before the Taglu drill rig was put in, so we had some background information on the movements of the flightless geese and their broods. The most seriously affected were the whitefronted geese, which evacuated an area for up to ten miles away. The snow geese stayed farther out on the periphery of the outer edge of the Mackenzie Delta and the swans did not use the channels where we had found them with their broods in prior years. The general impact on the area is of course variable depending on each species. Some species were actually attracted to the site. The drilling mud stacked up in pallets provided nesting cover for snow buntings which had not been found nesting in that part of the Delta

at all. The rig site actually attracted ravens also, in other words there was a plus two of being attracted to this site, even though the company did keep a fairly clean camp and incinerated all their garbage. From studies done by consulting firms and by ourselves at Anderson River and Kendall Island Bird Sanctuaries, has shown that geese, especially flying geese as opposed to molting geese will move and are disturbed by noise of equipment and by helicopter and aircraft. At varying times during the year some will disburse at a distance of up to five or so miles from head of the source of the disturbance, in this case helicopter or compressor station or what have you. I think we can relate what happened at Taglu to what could happen at a compressor station located on the north side of Shallow Bay. I think we can draw firm conclusions on the basis of the historical record of what had happened before. I suggest that an area of five to ten miles depending on how well the aircraft are controlled around the compressor site will not be used by any staging geese. As I mentioned before anywhere from 200 to 500,000 geese, especially snow geese can be found in that area during the latter part of August and through the month of September and in some years into October.

The construction and operation of the Taglu gas processing plant, is located close to the Taglu wellsite which we have already studied, in fact it's only a few hundred yards away. I can assume, without having all the information as to the size and noise

levels of the gas plant that it will probably have an impact somewhat similiar to the Taglu drill site. In other words it will have an effect on some species within a five mile radius of the plant site. It will affect the movements of other species in that area, in an area that has already been disturbed. In spite of the fact that it's an already disturbed area I do question why a gas plant , both the one at Taglu and I quess there's one being planned by Shell Oil, cannot be located in less sensitive areas, such as at Tununik on Richards Island.

MR BAYLY: Thank you Dr. Barry. Mr. Commissioner we just have this machine to finish setting up and perhaps we should do that before we go on .

THE COMMISSIONER: Mr Carter, would you make sure that when the Arctic Gas witnesses relating to the cross-Delta route are brought forward as I think it is intended next week beginning Monday-- make sure that the appropriate witness deals with the question of the sighting of the compressor station in the middle of the delta, in light of Dr. Barry's comment. If you have a witness who can comment on sighting of the Taglu Gas Plant and the Niglintgak Gas Plant you might bring that witness forward as well. I'm not suggesting that you are in a position to do so, but you might consider that and would you also make sure that Dr.Gun reviews Dr. Barry's evidence and comments on his testimony regarding the cross-Delta route and the issues that he's raised there.

MR. CARTER: Unfortunately sir we just got the evidence last night but I'll do my best.

THE COMMISSIONER: Well, I am sure that you can get Dr. Barry's evidence to Dr. Gun before Dr. Gun gets here. I've no doubt of that.

WITNESS BARRY: I might add that Dr. Gun and I have discussed this in some length, privately.

THE COMMISSIONER: I am sure you have, but I'd like to be privy to the discussion Well, we'll take a moment and you can set this thing up. Is that what you said ?

MR BAYLY: Yes, Mr. Commissioner, and we'll be making these photographs, exhibits or copies of exhibits before the Inquiry.

THE COMMISSIONER: Fine Are you ready Mr. Bayly ?

MR. BAYLY: Yes sir . Dr. Sergeant could you give your evidence to the Inquiry please ?

WITNESS SERGEANT: The following 40 slides are an attempt to give a visual image for approximately the first 8 pages, pages 2 to 9 of my testimony. However -- and also to give some extrabackground. It will unfortunately be necessary to go over parts of the testimony again, since I was unable totally to match the slides to the testimony. The animals I am going to talk about are two in number and one is a whalebone whale here; the bowhead as it was known in the Pacific, and the greenland whale in the

North Atlantic, reaching about 55 feet. This drawing was made in the North Atlantic in the mid 19th century and the next is a photagraph taken by my assistant off Cape Smoking Hills,Baillie Islands area, and you can see why it's gained the name bowhead; the protuberance on the head followed by a hollow and then the back. This is the only Arctic, truly Arctic whalebone whale and as with other Arctic whales it has no back fin. Clearly if we're going to buck ice you don't want a fin which is a fairly soft structure in the way. Occasionally a dead animal may be found on the Tuk Peninsula. We don't know why these animals die, whether these are natural causes or whether these are wounded animals from the nearest hunting which occurs at Point Barrow. We tried to discover with a metal detector on two of these animals but we were not able to establish any good evidence. This animal is one of the most important animals in the whole history of the Inuit, since the Inuit culture spread from North Alaska to Greenland in what is known as the Thule period in about-- I'm not an anthropoligist -- but I think about 1000 A.D. is correct. Following this whale is the mainstay of the economy. It was a marine culture and this same culture can still be found at Point Barrow, and even better at, I think at Point Hope, and a few other settlements in North Alaska. The Thule people relied on this whale almost throughout their range except around Victoria Island where they hunted caribou more, and you can find the old Thule houses all over the north particularly in the Eastern Arctic , with still

the bones of these animals inside the stone circles. The ribs were used presumably for skin tents above the stone circles and these are mostly the bones that are being used for carving at the present time. Apparently these bones need to be dry, free of oil before they're carved and I'm told that this leeching of the oil takes a long time.

The animal also became very important for European and North American hunting later starting from the other side, from the North Altantic. This was first for oil with the Dutch in Spitzbergen,who then pretty well extirpated the animal, then the other Europeans joined in; the British and the Scots and others, around Greenland, finally into Davis Straight and Baffin Bay and later on in the fishery the baleen or whale bone became very important as corset stays, riding whips, and other material, for other things like that. And that is showing the six foot baleen, of the larger of the two animals we found in the Tuk Peninsula, and the smaller animal on the right, which stranded themselves for unknown causes. That's Mr. Hoek who has worked on this project with me.

The animal was almost extirpated from the North Atlantic and is now coming back in the Canadian Eastern Arctic Archipelago fairly satisfactorily. We see-- we saw about 15 last summer while working on narwhals. In the North Pacific it was fished later mainly from New England and then from San Francisco and Hawaii by the American whalers and from the 1860's onwards, and they came round finally to Herschel Island at the

end of the fishery and wintered there and this is when the major white contact with the people on this coast occurred. It was a fairly disastrous contact in that most of the original inhabitants of the delta who apparently , about two to four thousand in number died from diseases obtained from their first contact with large numbers of white people, measles, diptheria and the usual infectious diseases, and most of the people who live here I understand now, came at various times from Alaska, although there is some-- a few original inhabitants survived and apparently the whaling culture in the delta survived more or less intact-- not the method of hunting, which was by kayaks , but the processing of the small whales, the white whales.

This shows the-- where the bowhead in the Beaufort Sea-- how it came into this part of the world, from the logs of one whaling ship which hunted fairly extensively. The animals winter in the Bering Sea and down to the Okhotsk Sea on the Russian side,come in through the Bering Strait in early summer,move apparently to some degree northward but to quite a considerable degree along the North Alaskan coast following the shore lead and several recent expeditions have shown how they come along this wide shore lead or set of shore leads in early May, in April and May when they are hunted from Point Hope and Barrow and other places. The animals or some of them finally come into this sector of the Beaufort Sea in summer and may penetrate as far as the strait between Banks and Victoria Islands-- in an open summer

They then move out again in September. That row of black dots-- they're dots, squares are in September and they're moving out again quite rapidly in the first half of September.

This year in '75 was a rather intriging year as everybody knows; the supply fleet for Prudhoe had great trouble at the end of August and early September, and this recalls an episode when the American whaling fleet was badly stuck at about that same time of year in about 1870-- I forget the exact date-- and they had to leave the whole fleet and get away on boats and join the few ships that hadn't gone so far. This occured at Wainwright and the whole ships were lost but no people were lost.

The whales also this year appear to have had some trouble getting out from the delta region in the fall, but they seem to manage to slip out along the coast. The Americans were doing a survey after we left off -- after, in distance I mean. In the spring these animals seem to move in along the main leads, in May and they live on the plankton -- probably the larger planktonic small shrimps, although the food of this animal is rather poorly done because it has not been caught by white man in the modern whaling period, and in the 19th century there were not too many precise observations. But it strains the small animals of the sea with its whalebone or baleen and it can strain very small animals. That is why it has this very fine baleen.

Now there's nothing particularily rich about the northern waters and these animals, but this animal is restricted to the ice, probably by a rather more effective , geologically more recent whales which inhabit the Sub-Arctic waters. At any rate it has adapted itself extremely well for ice covered waters and appears to be able to detect the presence of (inaudible)and leaves at some distance.

Our modern observations follow pretty well Captain John A. Cook's -- I think his name is-- observations. These were up to '73, more or less casually obtained. In the Beaufort Sea Inquiry we got more intensive observations, mostly from people who were doing surveys for seals and sea birds. We combined these observations and you can see that the species does occur quite commonly now in Eastern Beaufort Sea in summer. We don't have a good idea of total numbers.From what we think are the total numbers of white whales and from the relative proportions of sightings we calculate perhaps 200 in this sector, but this is not very precise and presumably there are quite a large number of additional whales that don't come as far as this; just stay in the Chukchi Sea and so on.

The other species that occurs here is the white whale or beluga-- the second name really means white animal-- it's a Russian name but it's usually applied to a sturgeon, and belukha is the Russian version of the whale, so I prefer to use white whale. This is taken at Churchill. I'm sorry it's

a dirty slide, and there was at one time a fishery at Churchill on the Churchill River estuary in Manitoba and I was able to study this animal there. The head of a white whale. This is a toothed whale or porpoise. It has a small eye and an even smaller ear, which I think may be visible behind. It starts life as a small brown calf, becomes grey and finally becomes white, in adulthood, and it has about ten, eleven teeth in each jaw on each side. It doesn't use them for chewing but it does make jaw clapping noises apparently and it takes its food mostly by suction as many sea mammals do . It is like most of the porpoises, a highly social animal. A small population lives all the year in the Saguenay and St. Lawrence region where the water is very cold, all the year, and it's most easily seen there in Southern Canada, and one sees this behaviour which has recently been explained to me by a young graduate student. The animals are herding fish by this line behaviour, and sometimes the animals, besides coming around and letting others get the fish-- quite high level group activity. Another place where we have studied these animals is in an inlet in northern Somerset Island called Cunningham Inlet . This concentration was first noted by Tom Barry in the late '70's -- late '50's but it wasn't until 1973, when with the Eastern Arctic Pipeline becoming important as a concept, that we decided to have a thorough look at this and it turned out to be a very interesting place to study them because they were, first of all very closely accessible, secondly the water was relatively clear; we could see more or less what they were doing, which was

not true in the Mackenzie. The group usually numbers over a thousand in a small river estuary running off a limestone lowlands. This is Dr. Doug Hayland of Quebec City who is quite interested in remote sensing of these animals and I've been consulting him on some of the techniques. He has actually surveyed this group with aerial survey photography and estimated the size distribution and so on, by that method. Seen from the air a mass of animals in the period late July, first half of August in the river mouth and only in that period. They cannot get there earlier because of the ice in the inlet and they leave it again. And this is a very widespread phenomenon in the Arctic. Now the significance of this was not determined until fairly recently. Most people thought the animals were feeding. The animal occurs throughout the Arctic and lower Arctic also, including all the Siberian Coast which is really a mass of rivers and estuarys, almost joining up and most of the work is being done by the Russians. But when we found these animals in a cold-- really cold polar sea, we could see that the rivers had the significance of warm water in summer. The delta, as I pointed out. It was very difficult to see what was going on, and it still is because of the coffee coloured water and most of our observations are made elsewhere and we infer in the delta what is happening underneath that silt. The animals just-- their backs break the surface and we can count them but we can't see the calves which are brown and we can't see the grey animals very well.

Well, there the animals on the

edge of the delta and the Tuk Penninsula are a little clearer and they appear to be following along the edge of the shallow contour, and here further off the delta in July or August one can see them better.

Their movements in the Beaufort Sea are-- they come in from the west in the shore leads in about the same time as the bowheads, and incidentally the period when these animals come in is when the net melting of the leads in the daytime exceeds the freezing at night. And at night the beluga, white whales apparently sleep at the surface of the lead and it freezes and they leave an impression of their nose, and you can see these 20 or 30 little impressions in the ice from the air, and then they move on again. But if they came in earlier than that there would be a net freezing of the leads, so that timing of the migration is critical.

They then come in the month of June into the whole Beaufort Sea as far as we can see and we infer that they're feeding in the leads probably on the polar cod. One of the people who saw them there was Stephansson who crossed over from somewhere in Alaska to Banks, and observed this in late May, with these white whales in the lead as he was sledging across and he described the plankton bloom and this very rich developement of plankton that Dr. Grainger mentioned. They don't-- in late June they can still be seen-- apparently in 1974, a rather cold year pressing on the eastern end of the range trying to get as far as they could. Perhaps they use up the polar cod as they go and-- because there are a large number of them and always

searching for fresh fields and pastures. But then in July they move into the delta and this I think was '74, and you can see a large percentage of the sightings then come towards the delta or into the delta. And the second half of July-- not quite so marked but still the same distribution. Then in August when sightings are rather few, I think because in open water the wave action makes sightings more difficult, they are spread out at sea again, and there is actually a movement into the Liverpool Bay area; not shown very well there, late July and August, possibly in connection with the number of sea herring in that area but this is speculation or inference, small bits of evidence, Then as with the bowheads they move out west again in early September and go into the Bering Sea as far as we know in winter.

We have been able to estimate numbers by finding the maximum concentrations in the delta in summer. This probably does not include all the animals. The first observations we made in 1961, 1969 showed rather low numbers. I don't know whether this was due to inexperience and first case too late a date, or whether it was real. But any rate it then appeared that we were getting increased numbers up to 1974 when we had the biggest numbers of all, somewhere around 5,000 in the delta, and then they fell off again somewhat in 1975.

To anticipate it looks as if the delta is a calving sight-- c-a-l-v-i-n-g -- and what happened in 1974, was since it was a very cold year they needed to come to the very warm water for calving,

they came further in than usual, and therefore concentrated more and more easier to count than if they were dispersed. We then got an approach towards a real total or the highest total we could get, of about 5000 animals plus more in the Beaufort Sea. So the animal-- the population in this area numbers at least 5000. There are no other rivers that we know of where animals concentrate regularly other than halfway along the North Alaska Coast and once in the 1950's in Northern Banks, two small rivers there which are probably not open to them in hard climatic years.

The other thing that that map shows is, for my own data which wasn't complete, the increase in the number of artifical islands and a proposal I shall be mentioning later for an area where a sanctuary might be created free of human disturbance.

Well, the distribution of these animals in the delta as shown by the very excellent studies of Slaney , over four years is shown here by figures that I lifted from the most recent report which reached me about two weeks ago, and it's fairly clear that in 1975 at least, the biggest concentration of animals was in this western Mackenzie Bay region. A smaller one in Kugmallit Bay near Tuk and also a smaller one in the central Mackenzie Bay region, and only transient animals in the Pullen Island area. This appears to be a fairly typical pattern. Slaney have here grouped three years data, which makes it a little confusing but it does appear that the general pattern doesn't change very much; that there are something like three main

groups and a smaller transient group. Now if you look at these in relation to the river flow, these are equivalent in size to the-- in a general way to the flow of water in the various channels in the Mackenzie, The warm water in July. I haven't got the accurate cubic feet per second data, but there are three major channels, the east channel, the two west branches and a rather small outlet near Kendall Island.

Now, Dr. Grainger did a temperature survey on a cruise of the "North Star" in 1973, and my extrapolation of his temperature data shows that the warmest water is indeed at those two biggest concentrations of the western channels where the highest temperatures occurred up to 17 degrees celsius, and in Kugmallit Bay with rather lower temperatures, around 11 at Kendall Island. So the easiest explanation of the disposition of whales at this period is that they're seeking the warmest water.

THE COMMISSIONER: Dr. Sergeant there was some discussion earlier on, I think by Dr. Bliss about whether any whales , any white whales could be found in the summer in Liverpool Bay. Do you have any comment on that, are any of them to be found there?

WITNESS SERGEANT: Yes, we've had people working there for a long time, Dr. Grainger's staff. We don't think they calve there but we think they-- I think the Slaney Report showed quite well that they move there rather late in July, apparently after the calving season, and it's a feeding area. We don't think there's any calving areas of any signigicance. It's

colder water. They don't seem to come into the Anderson River mouth. Perhaps it doesn't open early enough, or something.

The animal has been of interest to man for some time, and the -- I'll mention the commercial fishery that existed at Churchill until the early 60's . It really disappeared when the factory got decrepit. The meat was used for mink ranches in Saskatchewan, and Manitoba, and the Cree, Chipewyan and Inuit hunters at Churchill were paid by the foot so they carved their initials in whale to show the claiment, and you can see a grey calf and yearling animal and some white adults.

In the delta the 19th century history of whaling is very interesting, and it appears that a large number of kayaks drove whales into the east channel. It took about 200 kayaks and it seemed to have been one big hunt. In this century it's been hunting animals singly or-- and at present this is done by powered canoes. But the use of the muktuk, which is the outer layer of the fat,and of the meat which is dried in the sun, has seemed to have remained the same, and this is still quite an important dietary supplement, and the hunters of course-- very much of a recreational event. And here at Kendall some years ago, some of the heads and flippers which we usually put in permafrost pits I recollect,and the meat drying,and I forget the exact treatment of the muktuk but it was rightly boiled I think and then dried.

In the Eastern Arctic, this is

at Whale Cove, The muktuk was eaten frozen. I think it's probably better to do that because it has a high vitamin C content which would be killed by boiling; at any rate, it's quite an important dietary to supplement. I think particularly in late winter it has, if I recollect, and I'm not a bio-chemist, quite high contents of vitamin A and D also.

Now this matter of the river mouth, Cunningham Inlet again from the air, it can be clearly seen there that there are many young calves -- there is one sitting on the mother's back and another one, I think, on the right middle suckling. We earlier discovered from a similar site in Hudsons Bay that there were young calves and we deduced that these rivers are entered for purposes of calving. There is very little in the stomachs of the animals in such situations. The feature of this animal, the calf is born without a blubber layer, so it is not insulated. The animals apparently remain in this warm water for a few days or possibly weeks, and then go to sea again when the calf has the blubber layer.

It appears that the narwhal doesn't use this strategy, it lives in deep cold water all the time, and the calf is born with quite a thick layer of fat. The bowhead is probably big enough that it doesn't matter, the cold water doesn't matter to it.

However, this in the delta is inference for the most part, although sporadic sighting of the calves were certainly described by

Slaney in both Kugmallit Bay and in western Mackenzie Bay. The rest of the pictures merely shown some of the activity in the delta. This is hunting by canoe as occurs mainly, I understand now, in Kugmallit Bay, formerly also at Kendall and Tent Islands, such-like sites. This is our own research ship the "Salvelinus" which has been in the delta for about fifteen years and Liverpool Bay area and has done a lot of work, particularly on fisheries/ and then this new activity, island building and I have some notes here that this was Immerk in '73. This was Immerk and associated structures in '75. This is Sun Oil Pullen, '74. These were all in July. This is the same.

This is just listed as a rig Mackenzie Bay, not identified. I don't know if anybody can. This was Adgo, '75 and this was Pelly Barge, '75; hope I got that right, yes.

Our own researchers in the delta -- I'm starting on page three here at the bottom -- went on intermittently from 1955 onwards. We earlier discovered that we couldn't find very much about the biology of the animals from the catch because the catch was highly selective of large animals. This is true in other places too, like Churchill and clearly it shows that the catching -- if from that standpoint -- conserves the animals. A certain amount of wastage of course, does not.

I mentioned the research done --

THE COMMISSIONER: Do you mind repeating that? The catch consists mainly of large animals?

A In other words, the Inuit select the big animals -- I should expand that. The males are bigger than the females and therefore, this type of catch takes about 70 percent or more males. Therefore, other things being equal, this should conserve the herds because there's probably a surplus of males. However, the wastage rate of present killing is fairly high. It cannot be measured but stranded carcasses are found around the coast, some people say about 50 percent losses over and above the catch which is around about 130 animals, a summer.

So, although our earlier research was looking at the basic biology of the animals and considering whether the catch was excessive, it would appear, as I gather some earlier testimony by Dr. Bliss also included, that with a population in the excess of 5,000 and catch of perhaps 200 thousand, including the deaths; this is quite a conservative catch. Certainly, it has been stable for many years, since at least the 1930's. The newer activities are, on the other hand, have clearly increased the human disturbance of the animals in the sense there are more vehicles and noises going on in the delta.

I have perused the Slaney reports and I find that really our own studies and the Slaney studies seem to be totally in agreement in anything that we have studied in parallel, and clearly the Slaney studies/which have been more intensive in the delta for the last four/years have marked the distribution in the delta much more thoroughly than we have done.

I mentioned the concentration of the animals towards the western part of the delta and table one exemplifies this. I divided the delta into three more or less equal sized parts. The western one from Shingle Point to Garry Island, the central from Garry to Pullen and eastern from Pullen to Toker Point, thereby excluding areas east and west of the delta proper. Using our own currents in various years, excluding 1961 which had very low totals, and may not have been complete or may have been too late in the season in a warm year; it appears that in every year, more than 50 percent of the animals and a mean of 60 percent occurred in that western sector. This may include one or two groups of whales, the bigger one usually in the southwest sector of this rather vague piece of sea, generally called western Mackenzie Bay, bounded on its upperstream part by Shallow Bay and with a small dent called Shoalwater Bay with the nearest hunting at Tent Island, in some years at least.

I've already suggested that the simplest correlation of the distribution of the whales is that the biggest groups are in the warmest water and since we have found in every area we worked that the warm-water concentrations, which in the delta, as elsewhere are only temporary for the period, roughly, of the month of July. Since these are always in other regions associated with calving then this what is happening in the delta with these groups.

There is very little feeding in the delta at all. In fact, as you've probably heard,

there is very little food in the delta estuarine waters of a suitable size for a white whale. The river fish would appear to concentrate in the very shallow waters indeed where the whales cannot follow them without risk of stranding themselves. The few stomach contents we have, suggest that the animals are feeding at sea before they come in. In other words, all that is left is hard cartilagineous parts, horny beaks of squid.

There appear to be no other major rivers utilized. It's rather difficult to say whether any other rivers could be utilized as an alternative -- the Anderson perhaps, but it's not very big and it maybe breaks up a little later, and perhaps it would hardly take 5,000 animals.

I should say that this is the biggest concentration in the river mouth except for the Nelson which is the outlet of the Saskatchewan River into Hudson Bay and this also has about the same order of numbers in summer.

Then comes the controversial question of what kind of disturbance is created by human activity to these whales, whether by hunting or by the activities of other boats or other noisy activities associated with the oil and gas industry. Well, the difficulty with whales is you can't really put them in the aquarium. I suppose we could ask Vancouver or New York if we could experiment with their animals but they're rather valuable so that we really have to infer from field observations.

We have found at Churchill that

white whales can tolerate human noise and activity. For instance, at Churchill Docks, where the mouth of the Churchill River is quite narrow, white whales constantly pass and repass the ships which are loading grain during the summer months. However, there is some evidence that calving concentrations are more sensitive to human disturbance. Thus, the number of whales at Churchill is quite small in summer as compared with the Seal River which is a small river about 30 kilometers to the north. Moreover, many of the whales at Churchill are in the mouth of the river and they are feeding on a small fish called capelin, really outside the river mouth and moving in with the tide and out again as the fish do.

Yet the Churchill River is much bigger than the Seal River and for many years we wondered what the Seal River concentration of about 1500 animals in the summer was all about so we hired some canoes from the local cooperative;when whaling went out, they were sports hunting and they said "But we can't charter to a government department". We said "we'll pay just as good money as the tourists"; so we chartered ten canoes and we drove them in and we had sort of beginners luck and at low water in the Seal River we found these things had the small calves which was how we discovered what was happening on this river. It was too small to have anything for the animals to feed on.

Now, we surmise that the Churchill River was once a good calving area. In fact, in 1950 when Dr. Doan from Winnipeg first went there to study white whales, as a result of their early researches

they set up the top of the Churchill River estuary as a sanctuary for calving animals but, quite clearly, there were fewer animals there than at the Seal and I really think it's a better area because it's a bigger river. We surmised that the Churchill River, with the settlement, at some point, which we couldn't identify, perhaps a long while back -- perhaps in 1932 -- 1929 -'32 when the railway extended to Churchill -- perhaps subsequently when the traffic increased and the ouboard came in, the animals moved to the Seal River for a calving site but continue to use the Churchill estuary chiefly as a feeding site. They're only a short distance apart.

This does produce some rather circumstantial evidence that perhaps the animals that are calving do require a rather quieter environment than the other animals.

At Cunningham Inlet and Lancaster Sound where we have been able to approach these animals very closely on the shore without disturbing them at all, you've only to skip a pebble at the top of the group of animals upstream and they'll panic. Presumably, the predators of white whales are things like killer whales and they're in the water. Polar bears don't often get at them, even in these situations. This Cunningham Inlet group was a calving group.

Low flying aircraft do cause disturbance, but airborne sound doesn't disturb to the degree of waterborne sound. None of these statements have been quantified in any way. We haven't started looking

at the sound pressures and frequencies which disturb whales in different situations, but quite clearly they're much more sensitive to waterborne than to airborne sounds.

Both Slaney and ourselves have looked closely at the correlations of human activity and whale behavior in the delta and I don't think either of us have reached any conclusive statements. Slaney has summarized it very well in their most recent report, if I may quote.

"The apparent variability in the reaction of whales to boats may be the result of a number of factors. For example, water depth, nearness of obstacles such as shallow water or land, boat type, boat speed, traffic intensity, recent experience of the whales and whether or not the whales are pregnant or accompanied by a calf. These factors, either singly or in combination could reasonably be expected to result in a change in the response of whales to the presence of a boat."

Nevertheless, I would wish to express my opinion that the calving animals are more sensitive than the other animals from observations. I regret--

MR. GOUDGE: I wonder Dr. if you can identify the document you read from?

A I'm sorry. Slaney 1975 White Whale Study for Imperial Oil Limited, Calgary, page 37,"Impact on Whales and Whale Hunting".

As far as I can see, the island building activity disturbs the transient groups of whales

to a slight degree, rather as Churchill Harbour did and possibly they acclimate to this. I would speculate that the calving groups of whales might be more sensitive. It's difficult for a man to put himself in the position of a calving whale. Possibly, the women in the audience might be able to do so more readily. But I suppose that.

Last night, in room 55 in the Mackenzie Hotel, I was above the bar and low frequency sound from the floor through the bar, through the legs of my bed, was quite disturbing and I presume that this would be the effect of a variety of waterborne sounds -- propellors, dredges, you name it. Probably it's quite disturbing in a maternity ward, although I can't really go much further than that.

There has, in the western part of the delta, where the biggest herds of whales have occurred since '69, inclusive at least, there has to date, been very little human activity. However, there are two proposals, or one activity and two proposals. One is of course, the Canadian Arctic Gas pipeline proprosal to cross the delta a little bit upstream of the main concentration. The nearest island, as far as I can see from "Oilweek" which is called Ikattok, I believe, a little bit downstream of that southwestern concentration and some activity with Ikattok and Adgo in that secondary western concentration --

THE COMMISSIONER: Excuse me, Dr. Sergeant, I wonder if you could just point those areas out on this map? This is not a bad map here and --

A I am pointing from a map in "Oilweek" of December 8 and it's rather hard to overlay all this because they're all different scales but the pipeline we have a mark -- the position of Ikattok appears to be approximately there, Imperial J-17. I think that's about it. Adgo, I have got two sites, about here and here. One is, a C-15 a P25 and F-28, are all labelled Imperial Adgo so I don't know which is which. According to that information those are the nearest islands -- the map does not distinguish actual past potential -- I don't know the symbols used.

THE COMMISSIONER: No, that's fine. You said that the crossing was upstream or downstream of the main concentration?

A It is upstream. In some testimony, which I was shown in which the representative of Slaney's was crossquestioned -- Mr. Webb -- I think the implication was that the whales rarely went as far as that but they didn't descend in intervals. There is a slight tidal movement by the animals. There is a very slight tide here, it's probably a slight up and down movement and if I may copy that on the map if I still have it here.

The 1975 distribution as shown by Slaney is approximately here. Again, I gather from the early evidence it is somewhat upstream of that.

THE COMMISSIONER: Just one thing and Mr. Goudge, you might check the transcript overnight. My recollection is that Mr. Webb came to this same map

and indicated that in one recent year, I think he said that this year, not this year, last year -- one to two thousand animals came in as far as the mouth of Reindeer Channel which is here, upstream actually over the crossing. I am not troubling you with this, Dr. Sergeant, but you might just check the transcript and we'll look at that tomorrow.

A I checked that transcript and I could not find from his testimony what point he was referring to.

THE COMMISSIONER: Well he was at this --

A He showed it on the map.

THE COMMISSIONER: This is Reindeer Channel and the mouth of Reindeer Channel as you see, is very slightly upstream if not coincident with the crossing. That is what concerned me at the time and that is the only reason I -- but at any rate, all of the offshore islands are certainly downstream of the main concentration across Mackenzie Bay. I've no doubt about that. Good. I've got that right.

MR. GOUDGE: What he said sir -- or least a preliminary identification of what Mr. Webb said was that for two years, 1972 and again in 1975, they've been seen as far as the mouth of this Channel, which, I believe, is Reindeer Channel, that's still some twenty or thirty miles from the end of Shallow Bay and two of the four years, they haven't been seen in that far.

MR. CARTER: Sir, Mr. Webb will be here with the environmental panel for Arctic Gas.

THE COMMISSIONER: Right.

MR. GOUDGE: Perhaps, sir, I would show this to Dr. Sergeant the end of the day.

THE COMMISSIONER: Show it to Dr. Sergeant overnight and he can review it.

MR. GOUDGE: Yes, sir.

A At that point, I have a certain dilemma in that if --

THE COMMISSIONER: Excuse me, Dr. Sergeant, this is an important question and that's why I had Mr. Webb go to the map and my recollection -- because I do remember some of things that occur here -- is that he put his hand on the map above -- upstream of the crossing at the mouth of Reindeer Channel and said "one to two thousand animals in each of those two years" and, though they didn't appear in other years, he was inclined to think, and you might check his evidence on this, that it was the turbidity of the water which made sitings difficult at the best of times --

A M-hm. It was very turbid.

THE COMMISSIONER: -- that may have accounted for the absence of any whales so far as they could see in those years when they observed none. At any rate, I just want to make sure that we're getting your opinion on that very important question and that you have clear understanding of what he said. When's he-- you said that he was coming next week, is that it? Next week?

MR. CARTER: Yes sir.

THE COMMISSIONER: Well pick -- now, have you got something else?

MR. GOUDGE: No, sir, but there's a fairly lengthy passage, perhaps Dr. Sergeant would like to look at it overnight.

A I have the transcript here.

THE COMMISSIONER: Well, you don't have to look at it. We'll all be here tomorrow morning and I see the Bayly children have begun to arrive, so we may well have to adjourn soon. But, carry on Dr. Sergeant and we'll return to that in the morning, perhaps, if you don't mind.

A At this point, I'm in something of a dilemma, because if it were necessary to obtain conclusive scientific evidence, it would be clearly necessary to have some precise quantitative information on the quantity and kinds of underwater noise which proved disturbing to whales. On the other hand, there is the risk that with the gradual approach of increasing disturbance to that area, with, I suppose an extention of island building in that general direction, as shown by the testimony of Mr. Shearer, I gather--

THE COMMISSIONER: Yes.

A The area would be almost completely invested at least by human activity. It would seem to me reasonable therefore, that some protective mechanism should be afforded these animals on the assumption that development continues. I have proposed

that a sanctuary be created in that region in which there be no human activity.

THE COMMISSIONER: Well, Dr. Sergeant, I think this is an important proposal you are about to present and I think we might adjourn now and you could begin again in the morning and though I wouldn't adjourn early except we have hearing tonight at eight o'clock tonight at the Legion to hear the people of the community and certainly all present are invited to attend. But it may be a late evening so I think we'll stop now and start again at 9:30 in the morning, would that be all right?

MR. GOUDGE: As far as I'm concerned, yes sir. I wonder is ten o'clock preferable given that there'll have to be some setting up of shop.

THE COMMISSIONER: Yes, let's make it ten o'clock.

MR. BAYLY: I'm just trying to get through this before Mr. Yates and company arrive.

THE COMMISSIONER: Well, I think we'll make it ten o'clock. It's a long day --

MR. GOUDGE: There's equipment that has to be set up sir, tomorrow morning.

THE COMMISSIONER: It's a long day and a long night, so -- a long evening anyway. Well, ten o'clock in the morning and for those who wish to attend tonight, eight o'clock tonight at the Legion.

(PROCEEDINGS ADJOURNED TO FEBRUARY 11, 1976)